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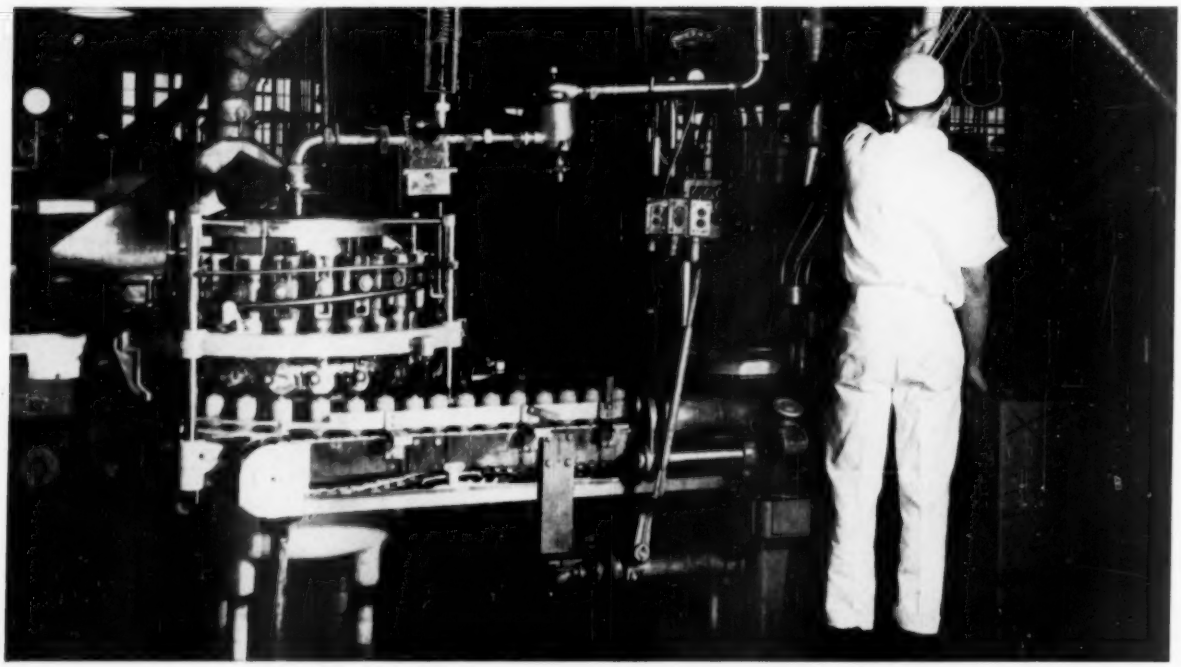

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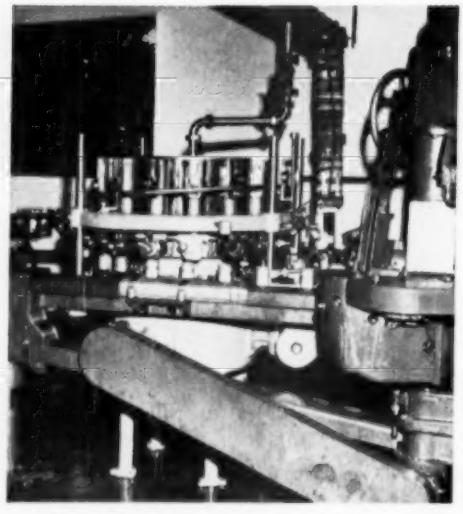

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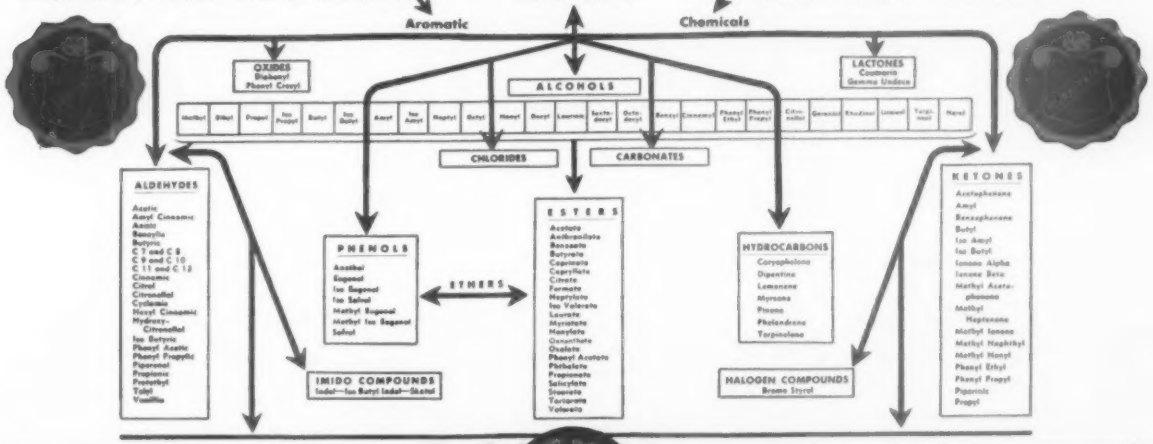

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The Vital Story of MARGARINE ENRICHMENT

How They Made Margarine a Better Food

by Science Writer

Over a hundred million pounds of margarine are used a month as a table spread, a tasty seasoning for hot vegetables and for many other purposes in cooking and baking. Included in the "Basic 7" food list, it serves as one of the finest and most concentrated energy foods. It is a shining example of a food which has been made repeatedly better.

In the original product which was invented more than 80 years ago, beef fats were used. Later these were replaced by lard and then by vegetable oils. When raw the latter, however, had several drawbacks: an unpleasant odor and taste, unsatisfactory color and a low melting point. These have been overcome by scientific refining methods, hydrogenation and use of certified food colors. Strictly phrased Federal Standards sponsored by the industry assure maintenance of very high quality, uniformity and nutritional value.

With this history of product improvement, it was natural that margarine makers would make their food a more valuable one by the addition of vitamin A. For over a decade many brands of table margarine were marketed with a label statement that they contained 9,000 International Units of vitamin A per pound. Now virtually all brands are enriched with vitamin A and the minimum amount supplied per pound is 15,000 I.U.—an increase of 40%.

Here are some of the benefits which vitamin A supplies. Scientific evidence is available showing that it helps to maintain normal vision and to overcome night blindness; that it increases the body's resistance to infections; that it promotes physical and mental development; and that it aids in maintaining normal glandular function.

Margarine makers who were accustomed to "fishy" odors and flavors when buying vitamin A sought a new source of supply. They found this new source in synthetic vitamin A—as produced by the famous synthesis evolved by the Roche research team headed by Dr. Otto Isler.

It was natural that margarine makers would adopt synthetic vitamin A for fortification of their products. When they were dependent on vitamin A extracted from fish liver sources, they found wide variations in vitamin A price. Synthetic vitamin A eliminated this disadvantage because its price is reasonable and stable. And a second disadvantage disappeared because synthetic vitamin A has absolutely no "fishy" odor, or taste, or after-taste!

Pure vitamin A and concentrates of it, produced by the Roche synthesis, have been approved by the Food and Drug Administration for use in margarine and other foods. It is light and clear in color.

Starting with citral, obtained from lemon grass oil, Roche vitamin A is built up through twelve manufacturing operations into a molecule identical with Nature's own.

At the huge Roche Park plant of Hoffmann-La Roche over 500 pieces of large-scale chemical engineering equipment in a multi-million dollar plant are working constantly to produce the superior Roche vitamin A.

Again, a development by the Roche people, who manufacture not only vitamin A but many other essential vitamins by the tons, has contributed to the making of a more nutritious food—and thus to the public welfare.

This article, reprints of which are available without charge, is published as a service to the food industry by Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada: Hoffmann-La Roche Ltd., 286 St. Paul Street, West, Montreal, Quebec.

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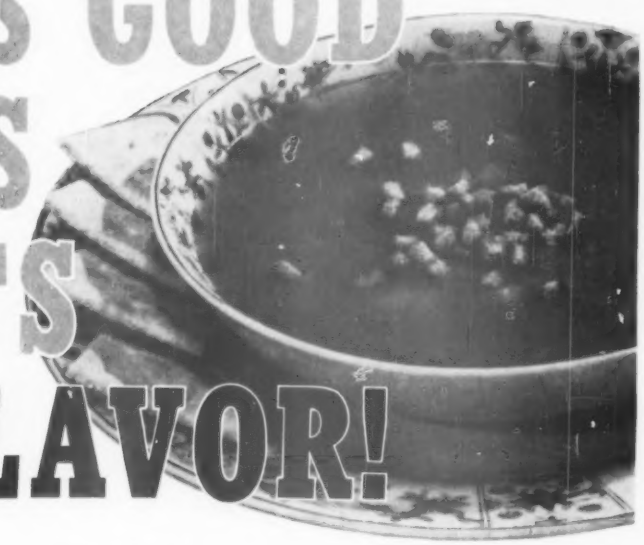

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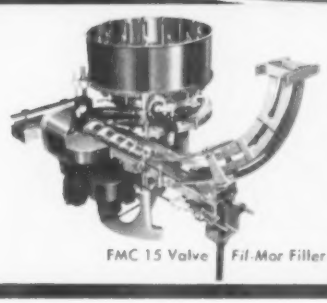
No doubt about it—this year's National Canners Convention will be the Biggest Show ever! We hope you will be there to share in the activity and to meet with FMC. Our main attraction is at Booths D-1 and E-2...come in and make yourself at home. See you in Atlantic City at The Greatest Canners Show on Earth—January 23 through 27!

Portion of FMC's exhibit at the 1953 National Canners Convention

FMC takes this opportunity to acquaint you with the experience, personnel, products and facilities of its Canning Machinery Division. In addition, exhibit panels of the more closely related FMC Divisions and Subsidiaries will be displayed, including those of Bolens Products, John Bean, Niagara Chemical, Packing Equipment, Westvaco Chemical, Ohio-Apex, Florida, Peerless Pump, and Stokes and Smith Co.



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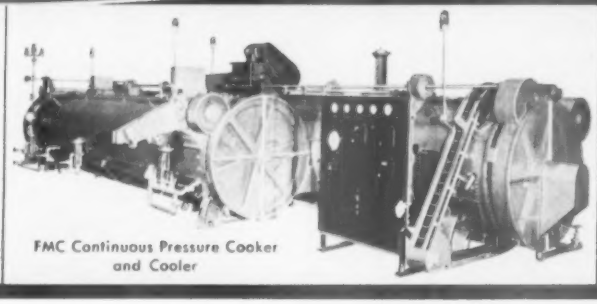

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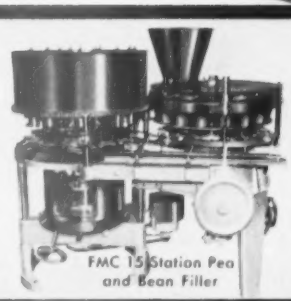
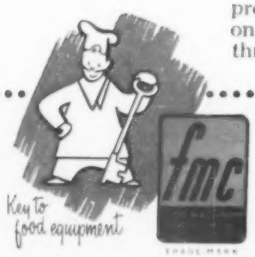


FMC 15 Station Pea and Bean Filler

Don't miss seeing these and other new and improved FMC key equipment items! They'll all be on display at the big Canners Show, January 23 through 27. Here's where you may discover just the piece of equipment you need to round out your line, or just the item to do your job more efficiently at lower cost. Plan to see us in Atlantic City at the Greatest Canners Show on Earth!



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Institute Commttiee Action on Food Technology Problems

The Institute of Food Technologists has grown to its present stature largely because it has provided a means of cementing the interests of men and women dedicated to intelligent application of science and engineering to methods of producing foods for human consumption. Its members enjoy the invaluable privilege of friendly association under conditions favorable to the exchange of knowledge and ideas. More tangible benefits are derived from participation in the technical programs of its regional and annual meetings. The Institute's journals, FOOD TECHNOLOGY and FOOD RESEARCH furnish channels of communication between its members and to the public.

Food technology is a field of technical enterprise heavily weighted with responsibility for the public welfare. Straightforward recognition of this obligation accounts in a large measure for the influential position which the Institute has established in the scientific and professional world. This notable progress has been accomplished by wise guidance of inspired leadership and shared responsibility by individual members.

Essentially, the business of the Institute is carried on by committees in accord with a pattern established by the constitution and supplemented by action of the Council. A complete roster of the current committees, together with a statement of the responsibility and/or the objectives assigned to each committee, was published in the November issue of FOOD TECHNOLOGY. These committees—thirty-one in number—really portray the management chart of the Institute. Rereading and study of this roster is recommended.

The technical committees, in particular, have a large responsibility for advancing the objectives of the Institute. It is likely that every member and all individuals associated with the food industry are or will be affected in some way by the problems which have been assigned to these committees for study.

Certainly, Chemicals in Foods is a subject of interest to everyone. It cuts across all areas of food production from the research project to the packaging material. This committee has done a splendid job of developing factual information concerning the use of chemicals in foods and making it available to all agencies interested in food protection and to the general public. Undoubtedly, this work constitutes a significant contribution to the fund of knowledge needed to provide a basis for equitable legislation on this important subject.

The Committee on Citrus Products was organized to deal with technical problems of industry-wide importance in the production of the very popular and essential citrus foods. It has been concerned with the development and use of methods and has rendered notable service in this field.

An infinite amount of technical know-how has been required to advance frozen foods to the important position which they now enjoy in the American diet. Much of this knowledge has emanated from research programs in university, government and industrial laboratories. Prime objectives of the Committee on Frozen Foods are to foster coordination of these research activities and focus attention on important factors which need additional study. A great deal has been accomplished and both the frozen food industry and the consuming public should profit from the activities of this committee this year.

The Committee on Pectin Standardization is actively engaged in a program directed toward establishing an acceptable method for grading pectin, a very important project relating to its wide use in the production of food products.

Since adequate procedures for Quality Control are vital to all branches of the food industry, there appears to be a large opportunity for the Committee on Objective Quality Control Measuring Methods to render a very constructive service.

Consumer acceptance presents an almost unlimited field for study and evaluation by the Committee on Taste Testing and Consumer Preference. There is a growing interest in this subject which emphasizes its importance.

Evaluation of Methods and Techniques used in Thermal Resistance Studies is a subject of major interest to the food processing industries. The objectives of this committee are designed to promote greater precision in judging the adequacy of sterilizing processes.

There has been a considerable amount of discussion concerning the responsibility of the Institute with respect to procedure for establishing definitions and standards of identity for food products. The Food Standards and the Executive Committees are working actively toward a policy decision concerning this important subject.

Every member should take a personal and active interest in the solution of these problems. Pertinent suggestions or questions would be appropriate and helpful. While direct responsibility for leading the attack rests with the 120 men and women who have accepted service on these committees, it seems certain that hundreds of others are qualified to participate. Somewhere among the objectives, opportunity is lurking for them to promote the technical program, contribute to the stature of the Institute, and enrich their own personal experience.

BERTON S. CLARK,
President, Institute of Food Technologists.

The Eighth Babcock Award Address

The fine tradition of responding to the presentation of a scientific award with an address that signalizes a scientific quest, or describes the long and patient pursuit of a missing link in a chain of evidence that will substantiate a theory, or presents in contemplative review the rewards of the life of science is a tradition that has a long history among English-speaking peoples—as it has, no doubt, among other nations. But it seems probable that there is one distinguishing theme that often recurs in the addresses of this category that are given before British, Canadian, Australian, and American scientific societies—namely, the theme that expending one's career in solving a single puzzle of the natural world can be a rich and ennobling experience. Dr. Frey, in delivering the eighth Babcock Award Address, recounts the patient struggles of many men in seeking to isolate and identify the fermentation factor. The story unfolds with what might be called judicious precision. But for those who will look deeper there is the theme—this has been my life; the pursuit of this problem has often been baffling but it has never been dull. For those at the beginning of a career in a technical field the eighth Babcock Award Address should have especial values—for in it is the scientific spirit, a force of profound influence in the life of modern man.

PRESENTATION OF THE EIGHTH BABCOCK AWARD

Dr. Fred C. Blanck

It is a privilege and a great pleasure for me to have the assignment of presenting to members and friends of the Institute the winner of the Eighth Babcock Award. It is stimulating to see such a large gathering of old and new members on this important occasion. Our attendance this year is the largest which we have ever had.

Since there are so many young and new members present, it seems fitting and proper that an informative statement be made about the donor, the great organization which has provided this most generous award in recognition of our society as a leading professional organization. Organized in 1942 by prominent members of the food industry, The Nutrition Foundation, Incorporated, has made grants exceeding three million dollars for research in nutrition. Since its birth, its members have contributed approximately five million dollars for the work of the Foundation in research and education. Briefly stated, the Foundation's activities are developed in five major areas:

1. Human requirements of individual nutrients.
2. Origin, function and measurement of individual nutrients.
3. Maternal and infant nutrition.
4. Public health problems in nutrition.
5. Educational projects.

As Dr. King has stated so clearly:

Scientists and others who know the history of progress in modern medicine, agriculture and industry have long recognized that advances in application follow reliably and steadily upon new, basic information. The Nutrition Foundation is primarily a result of faith in this relationship by leaders in the food industry. A further basic concept which has guided the Foundation's origin and growth, is the belief that success in our corporate life is strengthened by adherence to policies known to be basically in the public interest.

We, as members of the Institute of Food Technologists, can justly be proud of this magnificent activity of the Foundation supported by the food industry.

Selecting an awardee. The machinery provided for the selection of a Babcock awardee is relatively simple. A committee of nine members is appointed each of whom serves for a term of three years so that each year three new members are chosen for this work. The nine committee members submit nominees with supporting statements for consideration for this award. An initial ballot is sent to each member with a list of nominees and the necessary data; each member then indicates his first, second and third choices on the initial ballot. These ballots are then weighted, three points for first choice, two for second and one for third. The points for each nominee are totaled and the highest two become the nominees for the final ballot. The results of the final ballot then indicate the Babcock awardee for that year.

It now becomes my pleasant duty and responsibility to present the 1953 Babcock Award, the certificate, and a check for one thousand dollars to the winner, Doctor Charles N. Frey. Since the small commemorative brochure given you at the luncheon contains a sketch of Dr. Frey's accomplishments, it is not my purpose to enlarge on this statement by indicating the many scientific papers and patents of which he is either the author or a joint author, nor is it my purpose to list in detail the many honors which have been bestowed on him during his long and stimulating career. Instead I want to mention a number of the key characteristics of Dr. Frey—characteristics which stand out indelibly for all those who have had the privilege of knowing him. To begin with, notwithstanding his accomplishments, he has always been modest. He has ever been willing to share his wide knowledge with others. He has always been interested in helping younger workers along the path of progress. Throughout his long association with the world of competition—the industrial arena, if you will—he has always stood rigidly for what is right and best for his fellow men. His clear understanding and vision in dealing with problems affecting the food industry have been outstanding. He was one of the first industry scientists to hold full membership on the Food and Nutrition Board of the National Research Council. His writings have been characterized by clarity, brevity and force. Altogether, his career should stand out as a guiding light for young and up-coming members of our Institute. So I take great pleasure in presenting the 1953 Babcock Award to you, Doctor Frey, with my heartiest congratulations.

THE BABCOCK AWARD ADDRESS

THE FERMENTATION FACTOR

Charles N. Frey

In every man's life there come times of decision, and even if the action is of importance to only one person, it represents a momentous step to that individual. We are the products of our environment, and the forces

that have acted on us—if they are harmonious and generated by wise men—will often raise us beyond the orbits of our ordinary capabilities to those of higher potential.

During a series of lectures given during my junior year at college, Doctors Charles Marshall and Otto Rahn, professors of bacteriology, outlined some of the significant aspects of Pasteur's life and work. These lectures gave me new vistas as I looked into an interesting, intriguing, and to me, new world. Professors Frank Kedzie, A. J. Clark and H. S. Reed gave me an inspiring view of the elementary facts of chemistry. I decided to turn from the classics which I had pursued eagerly, following the traditions of the family, to devote myself to a study of the growth of microorganisms, their nutrition, and the nature of the toxic substances they produce.

As I advanced in my investigations, new horizons appeared, and I began to organize the problem. I hoped to develop methods of growing organisms in synthetic media and to determine the nutritive requirements of various types, their life cycles, and the nature of the toxic substances produced under various environmental conditions. I also planned to determine the nature of the substances produced by the host to prevent the growth of the parasite. Dr. L. R. Jones of the University of Wisconsin had carried on some interesting experiments *(16)* in this field, and he made a number of excellent suggestions in connection with my research problems.

Unfortunately, I found very little appreciation of the point of view I have outlined in 1910-1917 when I was pursuing graduate work. The plan was too ambitious and comprehensive for one of my limited training, and I was advised to limit my work to a few specific items in the categories I had selected as being of interest to me. Further, there was very little likelihood that I could find any association, college, or business enterprise willing to assist me financially to carry on such investigations.

The graduate faculty at the University of Wisconsin offered encouragement and advice. I wish to mention some of the professors whose cooperation and suggestions were very helpful: Richard Fischer, S. F. Acree, L. R. Jones, E. B. Fred, Walter Meek, W. H. Bradley, F. R. Jones, George Keitt, E. V. McCollum, E. M. Gilbert, E. B. Hart, J. Overton, W. H. Peterson, C. E. Allen, J. P. Bennett, E. T. Bartholomew, and Louis Kahlenberg. The published work of Dr. Samuel Prescott and some of his activities during World War I inspired me greatly. Dr. L. R. Jones suggested I try to study a plant pathogen. This seemed to be a logical procedure, so I began the study of a fungus, *Venturia inaequalis*, which attacks the apple leaf and fruit.

POINT OF DEPARTURE

The fungus has a complicated life cycle and could not be induced to develop the sexual stages in oatmeal agar or any other type of nutrient medium then available. It was parasitic on the leaf, and when the leaf died, it became a saprophyte and completed its sexual stage in winter and early spring. The apple leaf Dr. Keitt *(13)* and I found was highly susceptible when young, but we found it developed resistance with age. We discovered that ascospores were discharged from the leaves on the ground when the temperature and humidity were high, such as obtains in warm rains in May and June. Humidity and temperature must be exactly balanced to induce spore discharge. The spores are carried to a height of many feet, and thus may infect the topmost leaves of trees fifty feet high. We used the Cottrell precipitator type of equipment to collect the spores from the atmosphere. By measuring the cubic feet of air passed through the precipitator and counting the number of spores collected on the interior of the precipitator tube, we were able to determine the number of spores per cubic foot. We also developed a porous membrane consisting of the Whatman type of hardened filter paper which permitted the passage of air but retained the spores. By measuring the air pumped through the membrane and counting the spores on the semitransparent membrane, we were able to determine quantitatively the intensity of spore discharge.

The organism develops on the surface of the leaf and penetrates to the pectin and pentosan layer of the epidermal and palisade cell walls when the leaf is growing. The mycelium is limited, and the conidiospores arise from the limited mycelium and infect the young leaf and young fruit. We were not able to determine the type of enzymes secreted by the fungus or the nature of the substances giving the plant resistance. However, on the basis of this work some new conceptions concerning a spraying program were developed.

What type of nutrition is necessary to carry on the life cycle at various stages? What effect does temperature have, and why does the organism produce various types of growth when existing on the living compared with the nonliving leaf? What factors in the leaf offered resistance to growth of the organism? These were some of the questions I proposed to answer. Progress was made, but the work had to be discontinued because of World War I.

Studies on the nutrition of a number of organisms pathogenic to animals indicated further complexity. Growth involved the use of blood or animal tissues. Animal pathogens, I found, were as complex or more complex subjects for study.

A TURN IN THE ROAD

One day in 1915 one of the instructors was trying to grow yeast cells in a cane molasses preparation. He was unable to show budding yeast cells to his class because the cells failed to grow in the medium he employed. Because of my interest in the work of growing fungi, he turned the matter over to me. I was able to develop a solution that produced rapid growth of yeast over an extended period of time. Thus began my introduction to the yeast cell. This fascinating form of plant life has been the primary object of my scientific interest since 1917. It diverted me from my original field of activity which I deeply regretted, but I was able to obtain financial support by working on yeast. Year after year I

(Continued on page 13)

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PY-RAN'S greater stability means controlled release of gas even after long storage. Tests clearly prove how PY-RAN releases CO_2 slowly during first two minutes after dough or batter has been made. This two-minute reading is especially important, as any CO_2 evolved prior to this time will be unavailable for leavening action in baked goods. PY-RAN holds this gas for release at the proper time—during baking.

A slow, controlled gas release as produced by PY-RAN minimizes tunneling, coarse texture and other troubles. A baked product is produced which has improved texture and a uniform, small-cell structure.

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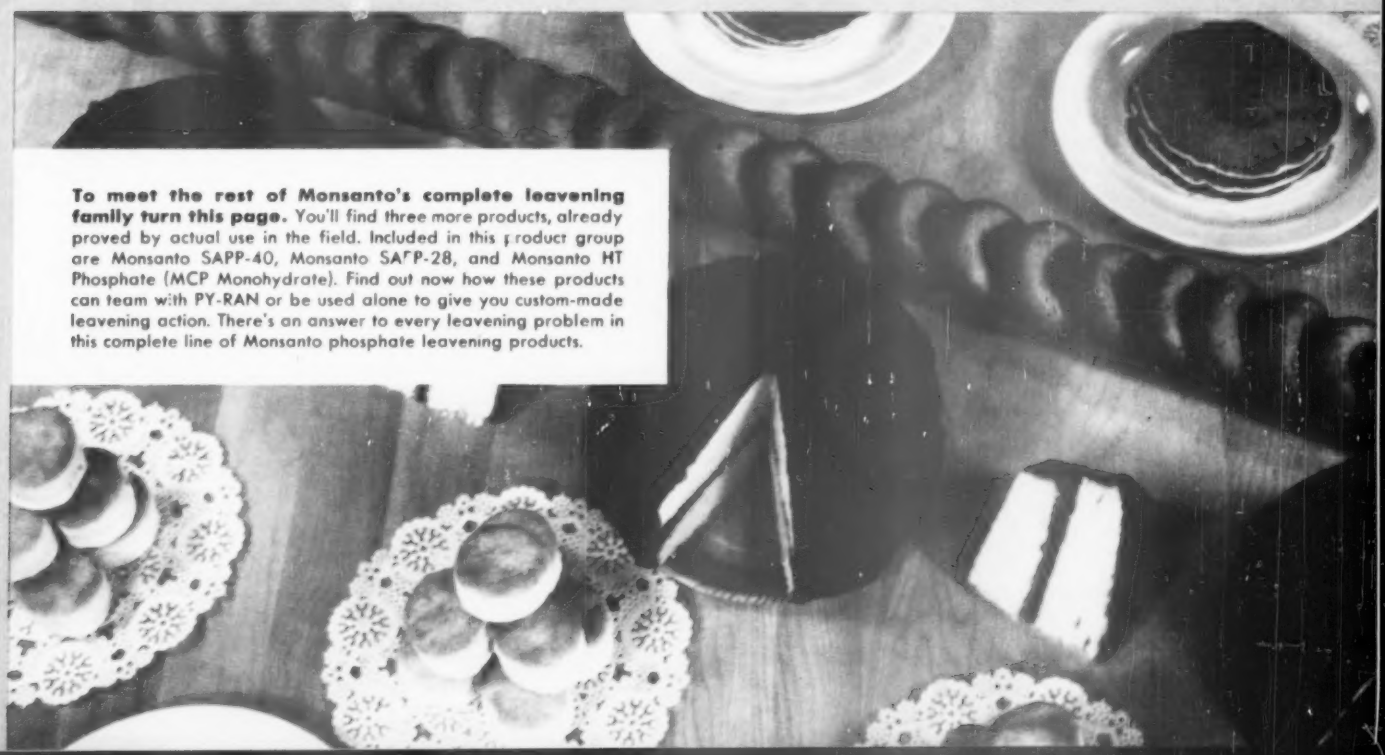
Test this product for yourself and see how PY-RAN'S controlled CO_2 release can improve your prepared mixes and self-rising flour.



To meet the rest of Monsanto's complete leavening family turn this page. You'll find three more products, already proved by actual use in the field. Included in this product group are Monsanto SAPP-40, Monsanto SAPP-28, and Monsanto HT Phosphate (MCP Monohydrate). Find out now how these products can team with PY-RAN or be used alone to give you custom-made leavening action. There's an answer to every leavening problem in this complete line of Monsanto phosphate leavening products.

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tried to broaden my work to include my earlier field of interest, but time and circumstances would not permit.

Many of the problems I outlined have yielded to such brilliant investigators as Alexander Fleming, Lash Miller, Roger Williams, Esmond Snell, Selman Waksman, R. R. Williams, Vincent duVigneaud, C. A. Elvehjem, C. G. King, and others. Great progress has been made, but my contribution was to be very limited. Today yeasts, molds, and bacteria are being grown in synthetic media. Insight has been gained into some of the factors causing cells to resist the attacking organisms, such as the production of substances that interfere with normal metabolism of the invading cells. Sulfonamides, lysozyme, and antibiotics have been discovered. We know the nature of some of the toxic substances formed by invading cells, and we know the chemical structure of many of the antibiotics and of some of the important vitamins that are required for the growth of microorganisms.

The yeast plant, *Saccharomyces cerevisiae*, grows readily in sterilized grain decoctions. It seemed in those early days to offer an interesting opportunity for the propagation of an organism in synthetic media. However, this study—begun with eager anticipation that important results would be forthcoming shortly—was not completed for certain strains of yeast until 1939-40; and in some types of yeast we are presently unable to obtain normal growth in synthetic media. Many research investigators gave years of their time to this problem.

Kohman and Hoffman *(18, 19)*, about 1912, reported that NH_4Cl added to doughs gave a better fermentation rate than when this salt was omitted. They definitely pointed out the effect of ammonium chloride on the rate of fermentation. Willard and Swanson *(47, 48)*, in 1911 and 1913, reported that NH_4Cl increased the rate of yeast fermentation in dough.

A NEW SCIENTIFIC HORIZON APPEARS

In 1915 I observed that acid NH_4 phosphate, $(NH_4)_2SO_4$, and NH_4NO_3 when added to 5% refined edible cane molasses solutions enabled bakers yeast [a] to ferment more rapidly and to grow readily in small 250 cc. flasks. Growth and a rapid fermentation rate were not obtained in pure sugar and mineral solutions; when growth was obtained it was very meager. Pasteur *(30)* had made the observation that yeast could grow in a mineral sugar solution, but a more rapid growth is obtained in the presence of organic material.

This statement of Pasteur was not fully appreciated. Wildiers *(46)*, 1901, stated that yeast did not grow readily in a sugar, yeast ash, and ammonium tartrate medium when a small inoculum was employed. When a sterile water extract was added, rapid growth took place. He assumed that a growth factor of unknown nature, which he named "bios," was necessary for growth. Amand *(1)*, 1902, stated that failure by Wildiers to obtain growth in synthetic media using a small inoculum was not due to the medium which is nontoxic. Devloo *(6)*, 1906, was able to grow yeast in a synthetic medium by adding a bios factor prepared from lecithin.

Pringsheim *(31)*, 1906, criticized the work of Wildiers. He stated that some growth took place in synthetic media; that bios was nothing more than a protein material which could be obtained from yeast. His work greatly influenced the interpretation of Wildiers' work and retarded the development of Wildiers' concept.

In 1919 Freda M. Bachman *(5)* in Dr. E. B. Fred's laboratory reported that yeast *(S. cerevisiae)* fermentation was stimulated when substances known to be rich in water soluble B were added to the synthetic nutrient medium she employed. She used three types of *Saccharomyces cerevisiae* yeasts, and the series of seedings ranged from dilutions of 1 loopful of inoculum to 1/3,200,000. All the yeasts fermented the synthetic media, but the rate was much more rapid if material rich in water soluble B was added. Bachman's measurements were not quantitative, but she definitely pointed out that the fermentation rate was increased in the presence of organic matter rich in water soluble B.

Roger Williams *(49)*, 1919, published a very comprehensive paper on the growth of bakers yeast *Saccharomyces cerevisiae* (Fleischmann) in synthetic media. He employed small seedings of 1-3 cells and noted that growth did not take place or was very slight in synthetic media. However, substances such as fullers' earth adsorbate of water soluble B (Williams and Seidell) when removed from filter cell produced an increased rate of growth. Milk, malt extract, wheat germ, and rice polish likewise affected the growth rate. Destruction of the water soluble B by acid or alkaline treatment sufficient to inactivate the factor for animal growth gave some negative results, indicating that the factor was destroyed. However, some of the experimental results obtained by the use of hydrolyzed products were not conclusive. Casein hydrolysate was not active in promoting growth.

Work at the Mellon Institute by Hildebrandt and Frey *(15)*, 1919-23, indicated that rice polish, rich in water soluble B, was effective in stimulating the rate of fermentation of yeast in sugar solutions and also in promoting growth. Hildebrandt and I tried to prove that the substance effective in stimulating the rate of fermentation was water soluble B.

A NEW CHALLENGE AND A RENEWED QUEST

We extracted rice polish and fed the extract to rats. Some extracts proved to be rich in water soluble B. All of the extracts stimulated the rate of fermentation, but unfortunately, not uniformly as measured by the rate of gas production. Other substances, such as malt sprouts, white flour, and malt extract, not especially rich in water soluble B, likewise influenced the rate. We treated substances such as yeast, wheat germ, rice, and malt with strong acids, also with alkalies, hydrolyzing the material by methods known to destroy water soluble B according to animal tests; but the rate of fermentation, while not corresponding with the water soluble B as measured by rat tests, was still beyond anything we could obtain in any synthetic solution we

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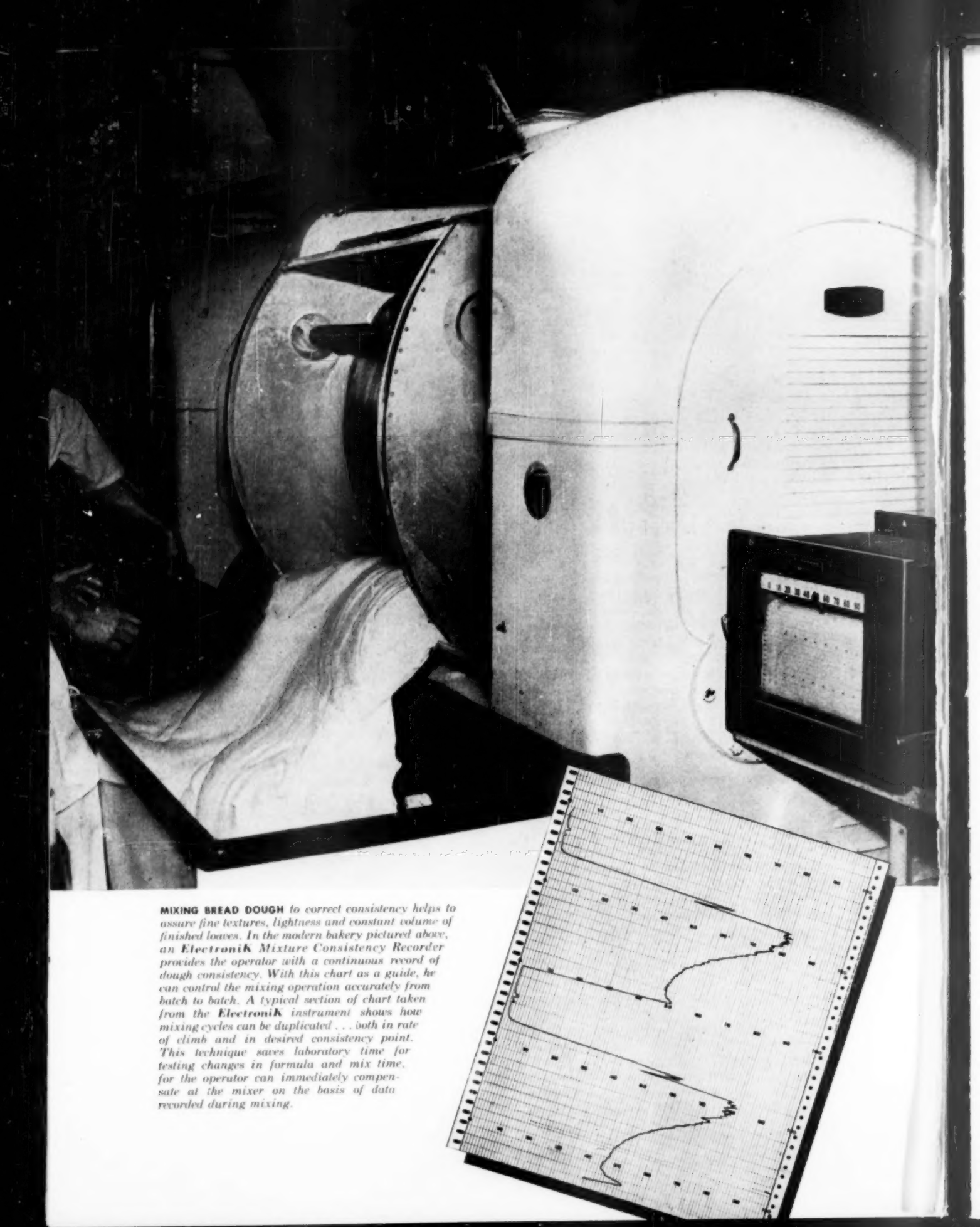
[a] Culture obtained from Fleischmann's foil yeast.



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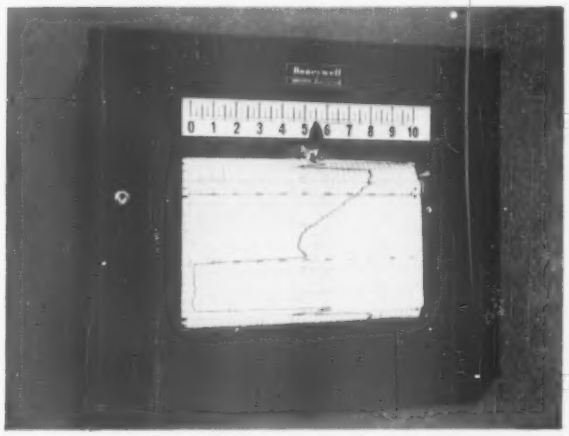

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were able to prepare. The whole subject seemed very puzzling.

Our goal became the preparation and study of a synthetic solution comparable to yeast extract, flour, or rice polish in accelerating the fermentation rate of bakers yeast.

In 1924 Euler and Swartz *(10)* postulated that a fermentation factor for yeast existed. They named this factor, Factor Z. It is present widely in plant and animal tissues. In Toronto, Lash Miller *(21)*, a noted chemist, and his students, Lucas *(23)*, Farrel *(11)*, Eastcott *et al. (8, 9)*, about 1920, began working on the nature of bios designated by Wildiers, 1904, as the factor present in certain organic materials responsible for yeast growth. They employed *Saccharomyces cerevisiae*. Miller and associates *(25, 26, 27, 28, 29)* isolated inositol and crude biotin, H A and H B. They proved to be growth factors, not fermentation factors. Roger Williams *(51)*, 1931, and *(52)*, 1933, identified the H A factor as beta-alanine. Williams *et al. (53)* isolated calcium pantothenate in 1939, and the Merck Laboratories, Williams and Major *(51)*, 1940, determined the structure of pantothenic acid and showed that it is a growth factor for bakers yeast. Steller *et al. (45)* synthesized it in 1943. Roger Williams *(50)*, 1930, and also Lash Miller *(24, 25, 26)* showed that B_1 is a growth factor for bakers yeast. Schultz *et al.* substantiated this work. In 1939 Schultz, Atkin, Frey *(37)* and Atkin, Schultz, Williams, and Frey *(2)*, 1943, showed that pyridoxine is a yeast growth factor and has a fairly definite effect on the fermentation rate. Experimental work seemed to indicate that it is necessary for protein formation in yeast. Pyridoxine is the T factor of Lepovsky and Jukes *(21)*, and the antidermatitis factor of György. It was isolated by Lepovsky, by Keresztesy and Stevens, and by Kuhn and Wendt in 1938. Its structure was determined by Kuhn and Wendt *(20)* and it was synthesized by Harris and Folkers *(14)* in 1939. Nicotinic acid *(36)* was found to have a slight effect on the fermentation rate. Kögl and Tönnis *(17)*, 1936, isolated and du Vigneaud *(7)*, 1942, determined the structure of Bios H B, which is now known as biotin.

In 1936 when B_1 was synthesized *(55, 56)*, it was made available to us through the courtesy of Dr. Randolph Major of Merck and Company, and Dr. Robert Williams. Schultz *et al. (32, 33, 35, 42)* found that in a synthetic solution of mineral salts and sugar to which B_1, asparagine, or ammonium salts had been added as the nitrogen source, nitrogen being necessary for the effect, and sodium citrate as a buffer, we were able to obtain a fermentation rate using Fleischmann's bakers yeast equivalent to that obtained in flour or rice polish.

Thus the long quest for the fermentation factor had produced further confusion. We had produced a fermentation rate comparable to that produced by a natural product, but in previous work treatment with acid hydrolysis and alkaline hydrolysis had been used to destroy B_1, and after treatment there was frequently no diminution of the response given by yeast in the presence of the acid or alkaline-treated product compared with the original. This effect was especially true in the case of acid-treated products. Was there another factor comparable in effect to B_1? Schultz, Atkin and Frey *(34)* with the assistance of Craig, Kirby, Light, Miller and Steele, had found that when acid hydrolyzed yeast, which contained no vitamin B by rat test, was added to a yeast mash, the B_1 content was enhanced far beyond the amount the original fresh yeast contained. This fact was established by rat tests. This observation seemed difficult to explain because bakers yeast is not capable of synthesizing B_1 rapidly. However, it will adsorb B_1 from hydrolyzed yeast or rice polish if the rice polish is finely divided or enzyme digested. In the case of the acid and alkali-treated substances, there is no longer B_1 to adsorb. How can these observations be rationalized?

R. R. Williams *(55, 56)*, 1936, had shown that B consists of two components, pyrimidine and thiazole. We tried each of these components in a fermenting medium. Schultz, Atkin, and Frey *(34)* found the 2 methyl 6 amino 5 ethoxymethyl pyrimidine served as the fermenttation factor for certain types of yeast. The pyrimidine is stable in acid and alkaline conditions, and thus is able to serve as an accelerator. The thiazole has a slight effect on the rate of fermentation of certain yeasts is the yeast is deficient in vitamin B_1.

With this information we were able to account for the discrepancies in our previous work. At least it seemed that we had reached one of the goals, and from this information we were able to initiate a number of interesting developments. In our work on the fermentation factor, we noted the uniformity of this response to increments of B_1 or pyrimidine of the 2 methyl 6 amino 5 ethoxymethyl type when added to the fermenting solution. A method for the determination of B_1 *(12, 32, 33, 35, 36, 42)* was developed which was widely used. By means of the sulphite treatment suggested by R. R. Williams *(41)*, one can inactivate the pyrimidine, the 5 ethoxymethyl 6 amino pyrimidine, present as such in B_1. It is not effective as a fermentation factor after treatment. The preformed pyrimidine, which stimulates the fermentation rate, present in the tissue is not affected by this treatment, and therefore the actual B_1 can be determined by difference. Thus the test becomes specific. It was adopted as an official A.O.A.C. method. Because yeast is not influenced by certain chemical substances which interfere with the thiochrone test when used on certain natural products, the method has been found useful.

This method enabled us to study foods low in B_1 *(3, 4, 36, 38, 42)* and to obtain accurate values as to the B_1 content. A study of the distribution of vitamin B_1 in the fractions obtained by milling wheat indicated that only 6-10% of the B_1 of the original wheat appears in the white flour *(4, 40)*. The B_1 content of many cereals *(12, 40)* and body tissues, and the fate of B_1 in the body *(22)*, as determined by measuring the excretion in urine and feces *(43)*, were determined. Control of the B_1 content of enriched bread *(12, 38)*, the stability of B_1 in various environments, and the use of vitamins in

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typing *(39)* and classifying yeasts were applications that proved to be useful and effective.

By using yeast, methods for determining pyridoxine *(37, 2)* pantothenic acid *(3)*, inositol *(39, 41)*, and biotin were developed. Some of these methods with modifications are still in use. The methods for the determination of inositol and pyridoxine have been widely used.

SOME APPLICATIONS

I stated previously that we had noted that hydrolized products rich in B_1, prior to hydrolysis by acids, recovered their B_1 content when placed in a fermenting solution, and B_1 seemed to be resynthesized by yeast. By adding 2 methyl 6 amino 5 ethoxymethyl pyrimidine and thiazole to bakers yeast suspensions, we found that yeast readily and efficiently synthesized these components to produce B_1. We grew yeast with 5-15 times the level of B_1 present in selected brewers dry yeast, and this type of yeast is still an important product in the food and pharmaceutical trade. B_1 initially could be synthesized more cheaply by means of yeast than by chemical means. This is no longer true. In 1936 we began studies on the enrichment of bread by means of this new yeast. In fact, as early as 1931-2 we had made a foil yeast for the household trade by growing the yeast in media consisting of rice polish extract that enabled it to produce a high B_1 level. The housewife was informed that if she used this yeast in bread making, she could greatly increase the B_1 content of her bread.

In 1938 bakers began to make a type of enriched bread by means of high B_1 yeast and 6% nonfat dry milk. Mr. Bohn of General Baking Company showed interest in this type of bread. At the time War Food Order No. 1 was issued, January 1943, about 120 million pounds of bread of this type were made every month. This type of bread continued to be made with additions of nicotinic acid and iron until about 1944-45 when riboflavin became available. Enrichment vitamins were made available in the form of tablets. Riboflavin discolored the yeast. Consequently, this form of enrichment by means of yeast was discontinued.

Another interesting development arose from our work on biotin. In Europe during World War I, chemists had attempted to grow yeast in beet molasses using urea as a source of nitrogen. The experiments were not successful. Our work began in 1920, and it was learned that cane molasses contains a factor which enables bakers yeast to utilize carbamide, but beet molasses is deficient in this factor and therefore growth was limited. Schultz *et al.* developed the work in this field. Patents were taken out covering a process for growing yeast using carbamide, and this process is in use in many countries today and lends itself to excellent control. It was later discovered by Schultz *et al.* at our laboratory that the factor present in cane molasses is biotin. Through the courtesy of Dr. V. duVigneaud of Cornell University and Dr. R. Major of Merck & Company, we obtained pure crystalline biotin and were able to substantiate our findings made on the very highly concentrated but not pure preparations of biotin prepared at the Fleischmann Laboratories.

I have failed to give a glimpse of the major fields of activity that the Fleischmann Laboratories have carried on, but time will not permit further discussion. Some fields that might be of interest are the development of vitamin D milk, based on the Steenbock discovery, production of ergosterol and vitamin D from yeast, production of irradiated yeast as a source of vitamin D, studies on nucleic acid, adenylic acid, and other derivatives of nucleic acid, yeast invertase, oxidases that destroy vitamin A and carotin, nitrogen and mineral nutrition of yeast, use of vitamin D in human and animal nutrition, production of stable types of bakers yeast, typing yeast strains, studies on dough conditioners, baking technology, the production of diastatic enzymes, the action of yeast in dough, the effect of various sugars on the fermentation action of yeast, and the nutritive value of yeast in terms of proteins and vitamins.

Many other activities of the Fleischmann Laboratories should be mentioned. The excellent work of Dr. Quick Landis as well as that of Doctors H. C. Gore, A. Shaver, S. Jozsa, and W. R. Johnston and Mr. G. Kirby should be cited. S. Redfern, J. Freilich, W. Maynard, O. Marshall, W. Tonkin, S. McHugh, G. Braun, O. Breivik, Bob Fisher, F. Swift, and H. Kothe have made many important contributions. These researches cover important fields, scientifically and commercially, and they have occupied the interest of the Fleischmann Laboratories for many years. It was, indeed, a pleasure to be associated with all the men and their associates mentioned in this paper. The work accomplished was largely due to their efforts, and the honor I have received is a recognition of their achievements.

The many phases of activity in yeast research indicate that a problem which seems relatively simple initially may become one's master for a lifetime.

LITERATURE CITED

1. Amand, A. Le "Bios" de Wildiers ne joue pas le role d'un contre poison. *La Cellule*, **20**, 225 (1902).
2. Atkis, L., Schultz, A. S., Williams, W. L., and Frey, C. N. Yeast microbiological methods for determination of vitamins. Pyridoxine. *Ind. Eng. Chem., Anal. Ed.*, **15**, 141 (1943).
3. Atkis, L., Williams, W. L., Schultz, A. S., and Frey, C. N. Yeast microbiological method for determination of vitamins. Pantothenic acid. *Ind. Eng. Chem., Anal. Ed.*, **16**, 67-71 (1944).
4. Atkis, L., Schultz, A. S., and Frey, C. N. Yeast fermentation. Am. Assoc. Cereal Chem., *Monograph Series No. 1*, Enzymes and their role in wheat technology, New York, 321 (1946).
5. Bachman, Freda M. Vitamin requirements of certain yeasts. *J. Biol. Chem.*, **39**, 235 (1919).
6. Devloo, R. Purification du bios de Wildiers. *La Cellule*, **23**, 361 (1906).
7. du Vigneaud, Vincent. The Structure of biotin. *Sci.*, **96**, 455 (1942).
8. Eastcott, E. V. Isolation and identification of bios I; its absorption by and recovery from yeast. *Trans. Roy. Soc. Can.*, (3) **22**, III, 267 (1928).
9. Eastcott, E. V. Wildiers' bios—The isolation and identification of bios I. *J. Phys. Chem.*, **32**, 1094 (1928).
10. Euler, H. von, and Swartz, Olof. Uber den Zusammenhang der wasserlöslichen Wachtsumsfaktoren mit Aktivatoren des Zuckerabbaues und uber einen thermostabilen Biokatalysator in der Hefe I. Zeit. *Physiol. Chemie*, **140**, 146 (1924).
11. Farrel, L. N. Influence of inositol, Bios IIA and Bios IIB on the reproduction of 12 species of yeast. *Trans. Roy. Soc. Can.*, III, **29**, 167 (1937).
12. Frey, C. N., and Hennessy, D. J. A comparative study of methods for the estimation of vitamin B_1. *Cereal Chem. Bull.*, **2** (2) (May, 1942).
13. Frey, C. N., and Keitt, G. W. Studies on spore dissemination of Venturia inaequalis in relation to seasonal development of apple scab. *J. Agr. Res.*, **30**, 529 (1925).
14. Harris, S. A., and Folkers, K. J. Synthesis of B_8. *J. Am. Chem. Soc.*, **61**, 1245 (1939); Synthesis of B_8 II. *Ibid.*, **61**, 3307 (1939).

15. Hilderbrandt, F. M., and Frey, C. N. *Reports.* Mellon Institute (1919) (1920) (1921).
16. Jones, L. R. Pectinase the cytolytic enzyme produced by Bacillus carotovorus and certain other soft rot organisms. *Bull. 147*, pt. 2, Vermont Agric. Expt. Sta. (1909).
17. Kögl, F., and Tönnis, B. Uber das bios problem. *Zeit. Physiol. Chem.*, 242-43 (1936); *Chem. Ind.*, **57**, 49 (1936).
18. Kohman, H. A., Hoffman, Charles, and Godfrey, T. M. Yeast saving composition for bread making. U. S. Pat. 1,151,526.
19. Kohman, H. A., Hoffman, Charles, and Blake, A. E. Economizing yeast in bread making. U. S. Pat. 1,158,933.
20. Kuhn, R., and Wendt, G. Functional groups of adermin. *Ber. Deut. Chem. Ges.*, **71** B, 1534 (1938); Constitution of adermin. *Ibid.*, **72** B, 310 (1929).
21. Lepkovsky, S., Jukes, T. H., and Krause, M. E. The multiple nature of the third factor of the vitamin B complex. *J. Biol. Chem.*, **115**, 557 (1936).
22. Light, R. F., Schultz, A. S., Atkin, L., and Cracas, L. J. The excretion of vitamin B_1 in the urine and feces. *J. Nutrition*, **16**, 333 (1938).
23. Lucas, G. H. W. Fractionation of bios and comparison of bios with vitamins B and C. *J. Phys. Chem.*, **28**, 1180 (1924).
24. Miller, W. L. Bios. *J. Chem. Ed.*, **7**, 257-67 (1930).
25. Miller, W. L., Eastcott, E. V., and Sparling, E. M. Fractionation of bios II. *Trans. Roy. Soc. Can.* (3), **26**, III, 165-9 (1932).
26. Miller, W. L., Eastcott, E. V., and Maconachie, J. E. Wildiers' bios. The fractionation of bios from yeast. *J. Am. Chem. Soc.*, **55**, 1502-17 (1933).
27. Miller, W. L. Wildiers' bios. *Trans. Roy. Soc. Can.*, (3), **28**, III, 185-7 (1934).
28. Miller, W. L. Wildiers' bios. *Trans. Roy. Soc. Can.*, **29**, III, 163-5 (1936).
29. Miller, W. L. Wildiers' bios. *Trans. Roy. Soc. Can.*, III, **31**, 159 (1937). *Ibid.*, III, **33**, 99-103 (1936).
30. Pasteur, L. Note sur un memoire de M. Liebig relatif aux fermentations. *Compt. rend. Acad.*, 1419-1428 (1871).
31. Pringsheim, H. H. Uber die sogenannte Bios Frage und die Gewöhnung der Hefe an Gezuckerte mineral salznahrlösungen. *Centralblatt fur Bakt. und Parasitenk.*, 2te abt., **16**, 111 (1906).
32. Schultz, A., Atkin, L., and Frey, C. N. A fermentation test for vitamin B_1. *J. Am. Chem. Soc.*, **59**, 948 (1937).
33. Schultz, A. S., Atkin, L., and Frey, C. N. A fermentation test for vitamin B_1 II. *J. Am. Chem. Soc.*, **59**, 2457 (1937).
34. Schultz, A. S., Atkin, L., and Frey, C. N. Thiamine, pyrimidine and thiazole as bios factors. *J. Am. Chem. Soc.*, **60**, 490 (1938).
35. Schultz, A. S., Atkin, L., and Frey, C. N. The specificity of the fermentation test for vitamin B_1. *J. Am. Chem. Soc.*, **60**, 3084 (1938).
36. Schultz, A. S., Atkin, L., and Frey, C. N. Influence of nicotinic acid on the fermentation method for vitamin B_1 determinations. *J. Am. Chem. Soc.*, **60**, 1514 (1938).
37. Schultz, A. S., Atkin, L., and Frey, C. N. Vitamin B_6 a growth promoting factor for yeast. *J. Am. Chem. Soc.*, **61**, 1931 (1939).
38. Schultz, A. S., Atkin, L., and Frey, C. N. The vitamin B_1 content of wheat, flour, and bread. *Cereal Chem.*, **16**, 643 (1939).
39. Schultz, A. S., Atkin, L., and Frey, C. N. The biochemical classification of yeast strains. *J. Bact.*, **40**, 339 (1940).
40. Schultz, A. S., Atkin, L., and Frey, C. N. A preliminary survey of the vitamin B_1 content of American cereals. *Cereal Chem.*, **18**, 106 (1941).
41. Schultz, A. S., Atkin, L., Frey, C. N., and Williams, R. R. Application of the sulfate cleavage of thiamin to the yeast fermentation method. *J. Am. Chem. Soc.*, **63**, 632 (1941).
42. Schultz, A. S., Atkin, L., and Frey, C. N. Determination of vitamin B_1 by yeast fermentation. *Ind. Eng. Chem., Anal. Ed.*, **14**, 35 (1942).
43. Schultz, A. S., Light, R. F., and Frey, C. N. Vitamin B_1 metabolism in man. Excretion of B_1 in urine and feces. *Proc. Soc. Exp. Biol. and Med.*, **38**, 404 (1938).
44. Stantial, H. Effect of inositol, of bios II, and of both together in the culture medium, on the reproduction of twelve kinds of yeast. *Trans. Roy. Soc. Can.*, (3) **26**, III, 163-4 (1932).
45. Stiller, E. T., Harris, S. A., Finkelstein, J., Keresztesy, J. C., and Folkers, K. Pantothenic acid VIII. The total synthesis of pure pantothenic acid. *J. Am. Chem. Soc.*, **62**, 1785 (1940).
46. Wildiers, E. Nouvelle substances indespensable au development de la levure. *La Cellule*, **18**, 313 (1901).
47. Willard, J. T., and Swanson, C. O. Milling tests of wheat and baking tests of flour. Kan. Agric. Exp. Sta. *Bull., 177* (1911).
48. Willard, J. T., and Swanson, C. O. The baking qualities of flour as influenced by certain chemicals, milling by-products, and germination of the wheat. Kan. Agric. Exp. Sta. *Bull., 190* (1913).
49. Williams, R. J. The vitamine requirements of yeast. *J. Biol. Chem.*, **38**, 465 (1919).
50. Williams, R. J., and Roehm, R. R. The effect of antineuritic vitamin preparations on the growth of yeasts. *J. Biol. Chem.*, **87**, 581 (1930).
51. Williams, R. J., Bradway, E. M. Further fractionation of yeast nutrilites and their relationship to vitamin B and Wildiers' "bios." *J. Am. Chem. Soc.*, **53**, 783-9 (1931).
52. Williams, R. J., Lyman, C. M., Goodyear, G. H., Truesdail, J. H., and Holaday, D. "Pantothenic acid," a growth determinant of universal biological occurrence. *J. Am. Chem. Soc.*, **55**, 2912 (1933).
53. Williams, R. J. Weinstock, H. H., Rohrmann, E., Truesdail, J. H., Mitchell, H. K., and Meyer, C. E. Pantothenic acid. III. Analysis and determination of constituent groups. *J. Am. Chem. Soc.*, **61**, 454 (1939).
54. Williams, R. J., and Major, R. T. The structure of pantothenic acid. *Science*, **91**, 246 (1940).
55. Williams, R. R. Communication to the Editor. Structure of vitamin B_1. *J. Am. Chem. Soc.*, **58**, 1063 (1936).
56. Williams, R. R., and Cline, J. K. Communication to the Editor. Synthesis of vitamin B_1. *J. Am. Chem. Soc.*, **58**, 1504 (1936).

Regional Section News

AUSTRALIA NORTHERN SECTION

The East Sydney Technical College was host for the September meeting, which was held in the Food Trades School. A buffet dinner was prepared and served by student chefs, and the appreciation of their efforts was a tribute to the School's instruction in the culinary arts. After the dinner members listened to an address by D. W. Grover, Head of the Food School, who chose as his subject "Some Problems in Rheology—the Set of Jam, the Chew of Confectionery, the Flow of Chocolate." The November meeting was held at the C. S. R. Chemical Plant, Rhodes.

A group of Australia Northern Section members residing in the Northern State of Queensland are at present organizing a sub-section which may eventually grow into a separate section of the Institute. Responsibility for this move rests mainly in the hands of John Forsyth and Peter Lewis, both of Brisbane.

The Australia Northern Section will be host for the Fourth Annual Convention of the Australian Sections of IFT. Headquarters for the Convention will be the Hotel Ritz, situated at Leura in the heart of the picturesque Blue Mountains, and the dates May 26th to 29th, 1954. Overseas members of IFT travelling in Australia at that time will be made particularly welcome.

Tucker Box, the official newsletter of the Australia Northern Section, is proving of much value in keeping members informed of the progress of the work of the various 1954 Convention committees.

DIXIE SECTION

At a dinner meeting on October 14, Dr. F. W. Fabian, Michigan State College, spoke on, "The Science of Making Pickles." He stated that the U. S. leads the world in the art of pickle making and some of the biggest packers are in the south. In recent years pickle manufacturing has shifted nearer to areas of cucumber production which is up favorably to Georgia and North Carolina.

"Of 39 basic types of pickles," said Dr. Fabian, "more attention is being given to the mild types which can be made in 24 hours." The strong, high-acid, and high-salt pickles, which require from one to two years to manufacture and were popular a few years ago, are being rapidly replaced with a mild, low-acid, low-salty "quicky" pickle.

Dr. Fabian said that another trend in the manufacture of pickle was toward soluble spices and that none of the larger manufacturers use whole spices any more. The objections to whole spices are that they vary in strength, are very wasteful of flavoring, and cause discoloration of pickles.

The new type of pickle which Dr. Fabian described requires processing and is otherwise handled similar to canning. Since this product departs from previously

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Write to Technical Director, Diamond Crystal Salt Co., St. Clair, Michigan.

DIAMOND CRYSTAL SALT with Antioxidant

held definitions of pickles, it may be that a new description of pickles will be necessary to cover the product that is becoming currently very popular.

GREAT LAKES SECTION

The Section held its Fall Meeting on November 6, 1953, at the Hotel Allerton, Cleveland, Ohio. The event consisted of a tour through the plant of Telling-Belle Vernon Milk Co., an executive committee luncheon, an afternoon program, followed by a business session, and topped by an evening dinner program. After-dinner speaker was Frank A. Uniack, Disaster Relief Chairman, Cleveland Chapter, American Red Cross, who discussed "Natural Disasters and Relief." The papers heard on the afternoon program were:

"Activities of the Cleveland Food and Drug Administration"; E. B. Buchanan, Deputy Commissioner of Health, Cleveland, Ohio.

"Quality Control in Restaurant Management"; Margaret L. Mitchell, Vice President, Stouffer Corporation.

"What a Quality Control Program Should Consist of in a Food Plant"; Hal Delo, Gerber Products Company.

MARYLAND SECTION

The September and October meetings of the Maryland Section were both stimulating and instructive.

On September 18, 1953, the speaker was Mr. Thomas Wason of the J. Walter Thompson Advertising Agency of Chicago, Ill. His extensive experience with food products as an account executive for some of our large manufacturers enabled him to hold the undivided attention of his audience. His topic was "Advertising a New Food Product." The talk was followed by a question and answer period.

The speaker for the October meeting was Dr. John Clague of the Food and Development Division of the Navy Department of Supplies and Accounts. Dr. Clague briefed those present on the activities of the Navy Recipe service and some of the problems encountered in the formulation of Navy messes for special situations. These included the foods required for long range submarine action, where the craft may stay under water as long as three weeks without surfacing. The requirements here were quite different from those of aircraft operation or amphibious landings.

A series of slides concerned with field testing of foods added interest to the meeting.

NORTHERN CALIFORNIA SECTION

Dr. G. M. Dack, Professor of Bacteriology and Director of the Food Research Institute at the University of Chicago addressed the August 13th meeting held at the Hotel Richelieu, San Francisco. His topic was "Food Poisoning." Dr. Dack is the current President of the Society of American Bacteriologists.

Dr. C. Glenn King, Scientific Director of the Nutrition Foundation, New York, was the guest speaker at the August 25th meeting held also in the Hotel Richelieu, San Francisco. He spoke on the role of food technology in nutrition.

Dr. M. J. Copley, Director of the Western Regional Research Laboratory, and also responsible for the

(Continued on page 22)

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REGIONAL SECTION NEWS

(Continued from page 20)

administration of all the Bureau's laboratories in the Western Region, addressed the October 8th meeting. Title of his address was "Food Research at the Western Regional Research Laboratory." The meeting was held in the El Cortola Restaurant, Oakland, Calif.

NORTHEAST SECTION

Doctor Samuel A. Goldblith, assistant Professor of Food Technology at Massachusetts Institute of Technology, and consultant for Arthur D. Little, Inc. received a plaque commemorating his winning of the Monsanto Presentation Award at the first meeting of the Northeast Section of the Institute of Food Technologists this year, held October 1, 1953, at the Harvard

Monsanto Chemical Award presentation at October 2nd meeting of Northeast Section, IFT. Left to right: Doctor Samuel A. Goldblith, Mr. James Donovan, Chairman of Northeast Section. (Doctor Jean F. Caul of Arthur D. Little, Inc.; Doctor Bernard E. Proctor, past-President of the IFT.)

Club of Boston. The Monsanto Award honors Professor Goldblith for the well organized and excellently delivered paper that he presented before the Thirteenth Annual Convention of the IFT last June. His winning paper was entitled: "Relative Bactericidal Efficiencies of Three Types of High-Energy Ionizing Radiations." This paper was chosen from among over a hundred presented before the IFT on this occasion.

The Monsanto Chemical Company, a manufacturer of chemical products including flavoring materials, leavening agents, and other items applicable in the food industries, seeks to signalize, through its honorary monetary award and plaque, the outstanding contributions and presentations of the papers given at annual IFT conventions. Another such award will be made at the annual meeting in Los Angeles, June 27-July 1, 1954.

A word about the 1953 winner. As a citizen and member of the Armed Forces, Professor Goldblith served from April, 1941 until February, 1946 in the war. Four years of that time were spent overseas in the Southwest Pacific Theatre. A Second Lieutenant in the Corps of Engineers of the U. S. Army, Professor Goldblith survived the "Death March of Bataan" and three years of a Japanese prison camp, and was awarded the Silver Star. During his years in the prison camp, he collected nutritional data.

Professor Goldblith is Technical Aide on the Subcommittee on Radiation Sterilization, of the Committee on Foods, National Research Council. A member of the Institute of Food Technologists he is also a member of the American Chemical Society, the Society of American Bacteriologists, the New York Academy of Sciences, the Association of Vitamin Chemists, the American Association for the Advancement of Science, the Century Club of Boston, the Richard C. MacLaurin Masonic Lodge, and of Sigma Xi, national scientific honorary society.

The November meeting was held at the Harvard Club of Boston. It began with a cocktail hour and was followed by a dinner after which Lyle Richardson, of the Foxboro Company, spoke on "Instrumentation in the Food Industry." Our November meeting presented an opportunity to get acquainted with the role that industrial instruments play in the engineering revolution that is quietly taking place in the food industry. Lyle Richardson, speaker of the evening, was born in Boston and received his education under Bernie Proctor at M. I. T. During the war, he was a member of the Quartermaster's Subsistence Research and Development Laboratory, Chicago. He has had experience with a wide variety of food products and processes at the National Tea Company, Beatrice Foods Co., Chicago, and at Lever Brothers. For the past three years he has been Manager of the Food Industry Division of the Foxboro Company.

The December meeting will be our annual Ladies' Night. Jean Caul has arranged a very interesting program. More about this later.

The secretary, on request of the Executive Committee, will now serve as a "clearing house" for Northeast Section employment information. If you are looking for a position or for someone to fill a position, you are welcome to send that information and it will be passed along. You may also know that there is a national clearing house on employment. You can obtain detailed information on this subject (including rates for a notice in FOOD TECHNOLOGY) by writing Colonel C. S. Lawrence, Executive Secretary, Institute of Food Technologists, 176 West Adams Street, Chicago 3, Ill. Ernie Barron is chairman of the Membership Committee. Application blanks for National or Sectional membership in the IFT can be obtained from him. His address is First National Stores, Inc., Somerville, Mass. Phone Prospect 6-2400.

OREGON SECTION

On October 2nd, 1953 this Section met at the United Air Lines' facilities, Portland, Oregon.

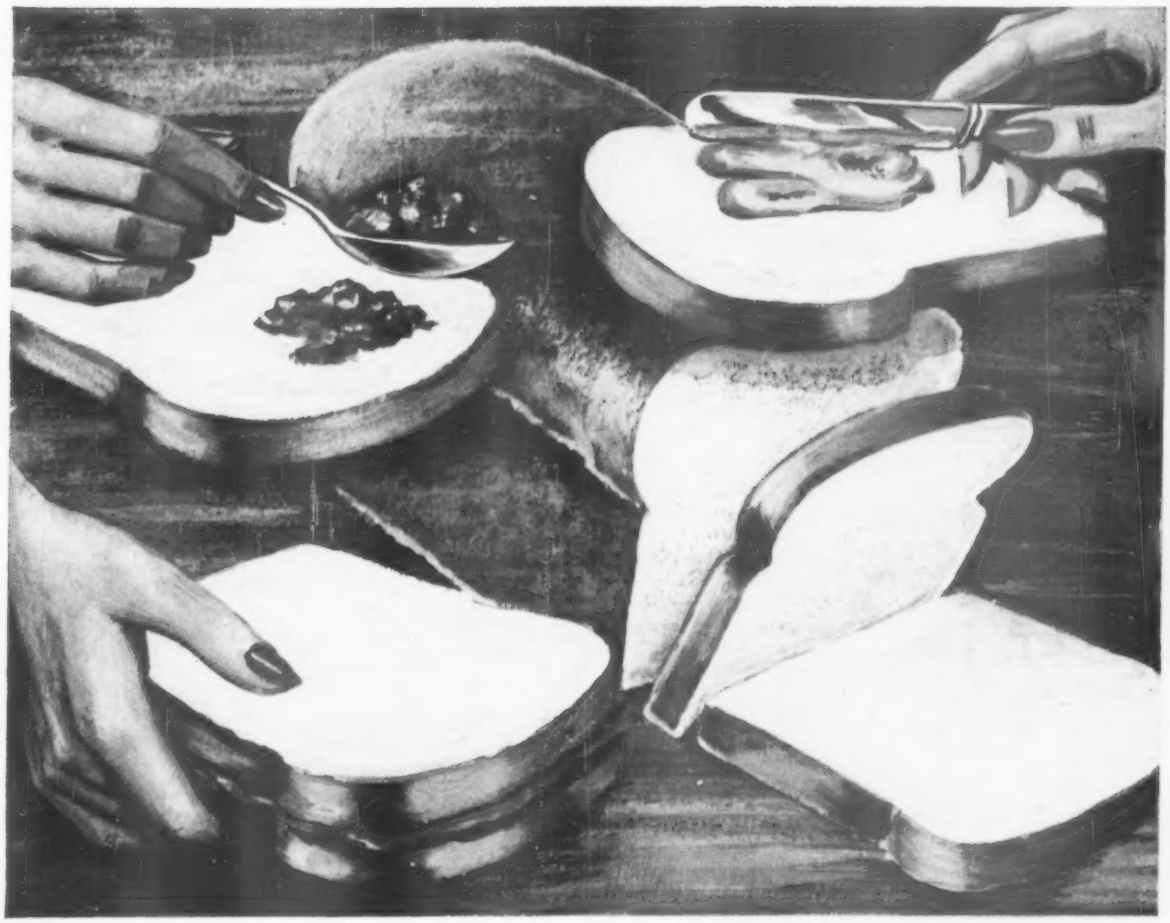
The following was the program for the meeting:

A tour of the United Air Lines' flight kitchen.
"Dining in the Mainliner Manner"—a talk by Supervising Chef Ernest M. Maurer.
"Highway to Hawaii"—a United Air Lines picture.
Display of meals and dining equipment served aloft.
Business meeting.

PHILADELPHIA SECTION

At the first meeting of the 1953-54 season of the Philadelphia Section IFT, Mr. Pouchain, our chairman, appointed the following committees: Auditing—Robert

(Continued on page 24)



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REGIONAL SECTION NEWS

(Continued from page 22)

C. Bucher and Richard J. Spiers; Publicity—Harry E. Dessender; House Committee—L. W. Mahle and Keith West.

The November meeting was held Thursday, November 5, 1953. The dinner speaker was Dr. Edward F. Kohman, who told of his interesting trip to Hawaii. Dr. Lloyd A. Hall, Technical Director, Griffith Laboratories, gave the address of the evening, speaking on "Some Aspects of Controlling and Stabilizing Food Flavor." Dr. Hall, a native of Illinois, is widely known in the field of food chemistry, especially for his work in the field of meat curing, seasonings, emulsions, bakery products, anti-oxidants, and protein hydrolysates.

PITTSBURGH SECTION

On October 13, 1953, the Pittsburgh Section held its first meeting of the year 1953-54 in the Royal York Dining Room. After an excellent dinner, Dr. G. C. Jenison, Director of Container Research, Weirton Steel Company gave a very excellent review of his "Observations on Can-making and Canning in Europe." Dr. Jenison recently returned from Europe where he gave a paper to the Technical Meeting of the Canning Industry at Stavenger, Norway, on April 6, 1953. His topic was "Tin Plate and Food Preservation in America." While he was in Norway, he visited the Norwegian Canning School at Stavenger and continued his visits to can-making establishments and canners in Norway, Denmark, France, Switzerland, Holland, and Belgium. His report of his observations of the canneries and can-making establishments in Europe and their comparison to American establishments was very informative and was well received.

NEW YORK SECTION

The New York Section held its first meeting of the year on October 21st.

The new officers and committee chairmen were introduced to the Section by the President, Mr. A. A. Schaal. Following a short basic meeting, Mr. Emile Corwin of the Food and Agriculture Organization of the U. N., presented a most interesting talk on the operation of F. A. O.

Mr. Corwin told the Section that there are now sixty-eight member countries and for the most part a request for help from F. A. O. comes from the country. It is F. A. O.'s aim to improve nutrition by whatever method is most practicable for the specific country involved. Their efforts may lie in the realm of providing agricultural implements or of teaching a people how to develop and make use of their natural resources. For example, the people of Thailand were suffering from a serious protein shortage. That problem was dealt with by demonstrating the use of a native fish which was available in abundant supply. In another case, the problem was destruction of crops through insect damage. And, again, their job may be improvement of an existing crop.

F. A. O. cooperates with the World Health Organization (W. H. O.). For example, they assisted W. H. O. in dealing with the so-called "Red Boy Disease" in South Africa by advising on the growing of high-protein foods. Another facet of their operation is the distribution to all member countries of printed material on the latest developments in food production, storage and transportation.

The overall aim of F. A. O. is the production of enough food to keep up with the increase of population. Their basic approach to this problem is their effort to reduce waste, to control plant diseases and insect pests, to improve storage conditions and to develop new land for cultivation.

WESTERN NEW YORK SECTION

The Buffalo chapter of the Western New York Section of the IFT met at the Kathryn Lawrence Restaurant in Buffalo on October 7. Mr. C. W. Thomas, Jr., Merchandising Manager, Eastern Division of Owens-Illinois Glass Company, spoke on the subject "We Can Get Too Smart." Later an excellent movie "Glasstown U. S. A." was presented by Mr. Walker Vincent of Owens-Illinois. Since it was "cooks' night out" all the women present received fine gifts from the Owens-Illinois Company.

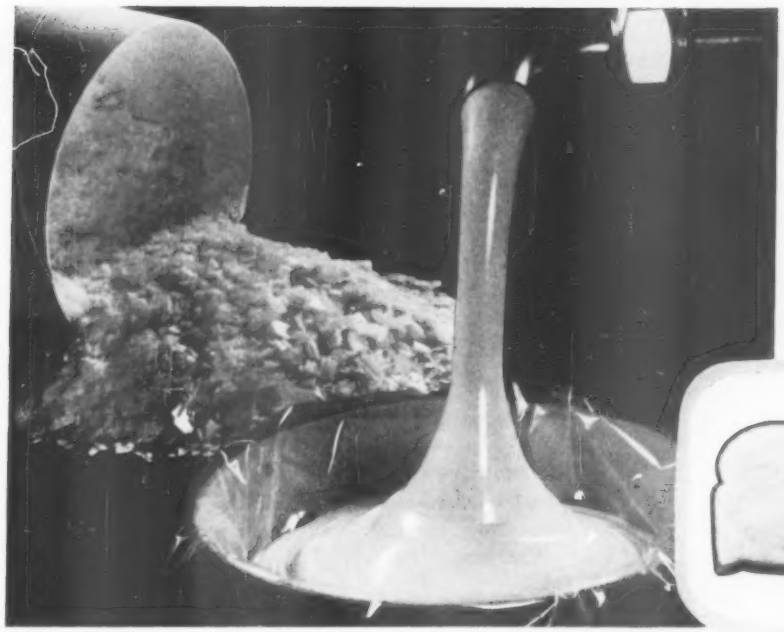
The second meeting will be held on Dec. 7th. It will be a joint meeting with the Cereal Chemists of Western New York.

PERSONNEL

The Institute of Food Technologists will be well represented on the program of the annual meeting of the American Association for the Advancement of Science, in Boston, Massachusetts, December 27-30, 1953. Symposia leaders in the program entitled, "Feeding the Nation," include Dr. Bernard E. Proctor, M. I. T., who will head the symposium on recent advances in food technology, Dr. Charles N. Frey, Consultant, Scarsdale, N. Y., who leads the session on chemicals in food, and Dr. Robert S. Harris, who with co-chairman Dr. F. J. Stare, Harvard, will conduct the symposium on the comparative nutritional requirements of animal species.

Among those presenting papers and otherwise participating in the Boston meetings of the A.A.A.S. are Charles Glenn King, Nutrition Foundation, Inc., Mary I. Barber, Consultant, Battle Creek, Mich., Henry Sherman, M. I. T., George F. Garnatz, Kroger Food Foundation, Wm. B. Esselen, University of Massachusetts, C. J. Bates, M. I. T., Sherman Leonard, U. of California, Samuel A. Goldblith, M. I. T., and W. A. Krehl, Yale University.

In a television program sponsored by the Illinois Institute of Technology under the title, "Choosing a Vocation," Dr. Ralph Peck, Dean of Chemical Engineering, Illinois Institute of Technology, spoke on chemical engineering; Dr. Carl Sammons, Standard Oil Company of Indiana, discussed metallurgical engineering, and Dr. Lloyd A. Hall, The Griffith Laboratories, Inc., presented the vocation of food engineering.



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Annual Meeting Bulletin Board

IT'S LOS ANGELES IN '54—JUNE 27 THROUGH JULY 1

Second Call for Papers. Although February 1, 1954, is the deadline for abstracts, it is necessary to emphasize that not much time remains to get under the wire with your contribution. Some of the symposia are already well along toward completion.

THE 1954 PROGRAM

Here is the program, as now established, together with the leaders of the symposia and their addresses:

Problems in Fruit and Vegetable Research and Technology

PROFESSOR JOHN H. MAC GILLIVRAY, Department of Vegetable Crops, University of California, Davis, California.

Flavor Changes in Foods as Influenced by Applied Chemicals

DR. CHARLES H. MAHONEY, National Canners Association, 1133 Twentieth Street, N. W., Washington 6, D. C.

Food and Drug Standards

MR. CHARLES W. KAUFMAN, Kraft Foods Company, 500 Peshtigo Court, Chicago 90, Illinois.

Citrus Concentrates

DR. W. R. ROY, Minute Maid Corporation, Plymouth, Florida.

Recent Basic Investigations in Food Science

DR. AKSEL G. OLSEN, General Foods Corporation, Central Laboratories, 11th and Hudson Streets, Hoboken, New Jersey.

Consumer Testing

DR. HELEN L. HANSON, Western Regional Research Laboratory, Bureau of Agricultural and Industrial Chemistry, U. S. Department of Agriculture, Albany 6, California.

Marketing Problems

MR. ROY H. WALTERS, General Foods Corporation, 250 Park Avenue, New York 17, New York.

Special Purpose Foods

DR. ERNEST GEIGER, 3842 Monteith Drive, Los Angeles 43, California.

Seafood and Seafood Products

MR. KARL ENVOLDSEN, Envoldsen Shrimp, Inc., 1200 West Ninth Street, Cleveland 13, Ohio.

Wine and Wine-tasting

MR. HAROLD W. BERG, Department of Viticulture, University of California, Davis, Californina.

Food Engineering

DR. CURTIS E. MAIER, Continental Can Campany, Inc., 4645 West Grand Avenue, Chicago 39, Illinois.

What's New In Food Packaging

DR. KENNETH W. BRIGHTON, American Can Compsany, Inc., 11th Avenue and St. Charles Road, Maywood, Illinois.

Pectin and Pectic Materials in Relation to Food Processing and Preservation

DR. REESE H. VAUGHN, Department of Food Technology, University of California, Davis, California.

Frozen Foods

DR. K. G. DYKSTRA, Birds Eye Division, General Foods Corporation, 162 South Main Street, Albion, New York.

Advances in Fruit and Vegetable Dehydration

DR. JOSEPH R. WAGNER, Qm. Food and Container Institute, 1849 W. Pershing Rd., Chicago, Ill.

General Papers

DR. ARTHUR N. PRATER, Gentry Division, Consolidated Grocers Corporation, 837 North Spring Street, Los Angeles 12, California.

Roundtable Discussions

DR. M. L. ANSON, Lever Brothers Research Center, Edgewater, New Jersey.

Southern California an Active Center for Food Research and Technology. Southern California is well equipped with publicly and privately owned research facilities. Many of these are concerned exclusively with the betterment of food or food manufacturing. Indicative, perhaps, of the attention being given research is the fact that the Los Angeles area is rapidly becoming a leading center for the development of scientific instruments. The production and development of electronic and optical measuring devices, formerly confined to centers east of the Mississippi, are now West Coast industrial interests. Most of the aids to the analytical chemist are now available to him almost next door. Food equipment manufacturers are also well established in the West, and the industry is closely coordinated with Western food production.

Institutional research. Research in the public interest is conducted in numerous places in California. At the University of California at Los Angeles and at the University of Southern California much interest has been developed in the field of nutrition, and few members of IFT are unacquainted with the work of two fellow-members, Dr. Harry J. Deuel (USC) and Dr. Max Dunn (UCLA). Notable contributions to our knowledge of nutrition have been made by both laboratories and, as one sign of their distinction, the findings made have crossed national borders to become well known internationally. At Pasadena the U. S. Department of Agriculture maintains its Fruit and Vegetable Laboratory. Although engaged in basic research the guidelines for the investigative work of this laboratory have always been industrial application. Under the guidance of Dr. E. A. Beavens (IFT member) the laboratory serves the fruit and vegetable industries of California and neighboring states. Several IFT members are counted on its staff including Dr. Louis Rockland, a past chairman of the Southern California section. Farther up the coast, in the Northern California region, at Albany, California, is the Western Regional Research Laboratory of the U. S. D. A. This organization, one of the four great laboratories maintained in the various regions of the U. S. by the Bureau of Agricultural and Industrial Chemistry, exercises under another active IFT member, Dr. M. J. Copley, general supervision of the Bureau laboratories in the Far West area. The purpose of U. S. D. A. work on the West Coast, as

(Continued on page 28)

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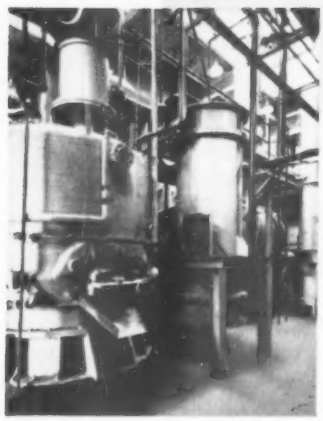

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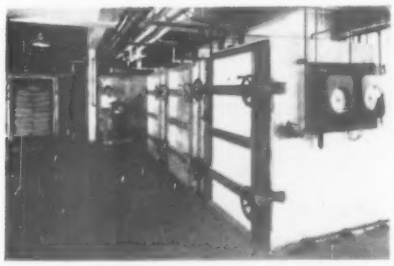

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(Continued from page 26)

elsewhere, is to add to the national wealth and income by discovering new and better ways to grow livestock and field crops and to find ways and means to utilize the products of the farm to the best economic advantage. Finally, in mentioning publicly supported research, the work of the Food and Drug administration in the West Coast area should not be omitted.

Industry research. Turning now for a quick look at industry-supported research, we are immediately confronted with a dilemma. So many of the great food companies of California and the nation are engaged in fundamental or applied research—and often both—that space prevents mentioning them individually. Work on citrus products, for example, is being done by both the trade associations and individual companies—more than a dozen of them. When one mentions the citrus industry the names of numerous IFT members—some fifty or sixty—would be listed. Since space is the problem, perhaps the name of A. J. Lorenz, because of his long association with the Institute and with the industry, can stand for the rest. It is perhaps natural to go from citrus products to another type of product associated with "southern climes"—spices and condiments. Much scientific work has been done in Southern California on spices, both those grown within the area and those imported from the Orient which lies over the Western horizon.

Running quickly over other product fields—several IFT'ers are associated with dairy products research, for example, Milton E. Powell, general chairman of the 1954 meeting in Los Angeles. The various companies that make up the dairy industry in California have well-equipped plants and laboratories. President-elect of IFT, Dr. P. K. Bates, is heading up one of the newest of these laboratories.

Cereal and bakery products research is being conducted in several places in the area, and the development of specialty foods, from salad dressing to honey, is an active technical interest. A score or more IFT members are engaged in this type of activity. It is not surprising that the beverage industries are active and prosperous in Southern California. Research on wine, on beer, and on the various fruit drinks, notably those prepared from citrus products, is extensive. Food technologists are to be found throughout these industries and have been instrumental, of course, in improving the standard beverage products and in the development of new ones.

Perhaps no area in the nation has maintained a more persistent interest in dehydrated foods than has the West. Not only has much attention been given to those foods that dehydrate well but effort has been made to bring the more difficult products up to market quality. In an area where crop surpluses can be depressing to the economy, efforts to find new channels of utilization are always followed with interest. Incidentally, at the 1954 annual meeting progress in the dehydration field will be delineated and for those not aware of the advances made many surprises are in store.

In reviewing industrial research, mention should also be made of that being done by the pharmaceutical companies, more than a dozen of which are located in the area.

Though not so large an industry as in certain other areas of the country, there is a sizeable pickling industry in California and several IFT members are engaged in technological studies in this field and in the fermentation field generally.

It is fitting, perhaps, to close this brief account with a reference to sea food research. Interested IFT members who attend the annual meeting in Los Angeles will find a world of interest in Terminal Island, the locus of the California industry and the site of extensive research laboratories devoted to marine products. Located here are several IFT members, among them Dr. Ernest Geiger and Dr. Sven Lassen.

Exhibit Space Rapidly Vanishing. John S. Beckett, chairman of the Exhibits Committee, writes: "If the 'shadows cast before' (booth space sales) are any criterion of the 'coming event' (1954 IFT Convention), it would appear that the whole World and his wife will be in Los Angeles next June!

"Past history of IFT Conventions indicates that at this time of the year, space requests are scarcely beginning to come in. For this Convention, to our amazement, the first request was received on *November 20, 1952!* By the end of July, 1953, with no solicitation started as yet, nearly 40% of the space had been contracted for.

"As of this writing (October 19), only 9 booth spaces remain out of an original total of 60. These range in size from 8 x 8 feet to 12 x 17 feet. They may or may not be sold by the time this is in print.

"At the time we contracted for the exhibit area, we thought that we had arranged for ample accommodations for all possible exhibitors. It begins to look as though we had quite definitely underestimated. However, we will still take care of all exhibitors—in fact we are already negotiating for additional floor space.

"In all seriousness, any company that expects to exhibit at the 1954 Convention would do well to act quickly."

Please take note . . .

The January issue of *Food Technology* will carry a progress report by the chairman of the technical program, Dr. Arthur N. Prater, giving the current status of each symposium with respect to the nature and general scope of the various sessions, their length, and other facts of interest. The reports are now coming in from the symposia leaders and the prospects for an excellent program of papers are most encouraging, Dr. Prater reports. A few of the symposia are virtually filled.

In an advance report of progress Dr. Helen L. Hanson, who is leading the "Consumer Testing Symposium," states that she has been informed of several promising papers on this topic that are under preparation. Dr. Hanson is endeavoring to have a program that will be of the greatest possible interest to those engaged in consumer testing. There are any number of methods available for consumer testing and for the most part they have been adequately described. How-

(Continued on page 34 following technical papers)

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Studies on the Toughness and Histology of Frozen Apricot Skins

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(Manuscript received June 6, 1953)

The texture of fresh, frozen and canned apricot skins are studied by several methods. Penetrometer and organoleptic comparisons are made immediately before and after processing and after several storage periods. Histochemical studies of the cell wall constituents of fresh apricot skins are reported. Microscopic studies are made of the fresh and processed skins. A developmental study of the histology of the skins from blossom drop to mature fruit is described. Frozen skins are not found to be actually tougher than the fresh, but their disagreeable texture is apparent because of changes which take place in the frozen flesh tissue. Canned apricot skins are truly more tender than fresh or frozen.

Previous investigations have repeatedly reported a disagreeably tough skin texture in frozen apricot halves [reviewed in Joslyn and Hohl *(7)*]. Consumers of the commercially frozen fruit have also expressed disapproval of this characteristic. During the last war there was approximately a 200-fold increase in total volume of apricots frozen. This was followed by a sharp decrease which brought the 1949 California pack to only a little over double that of 1941. During the following two packing seasons there was again a considerable increase followed by a decrease in 1952 *(14)*. These fluctuations were brought about by war and peacetime economic conditions, poor quality being better tolerated in wartime. It is impossible to determine just how much the overall acceptability of frozen apricot halves is affected by skin texture, but undoubtedly this factor is significant.

Botanically, the fruit of the apricot [*Prunus armeniaca L. (2)*] is a typical drupe. It consists of a single seed surrounded by a stony endocarp (these two parts together making up the pit), a fleshy mesocarp, and an outer skin or epicarp. The epicarp consists of an outer single later of epidermal cells—some of which have long hairs—and an underlying hypodermal layer probably of collenchymatous nature, which grades into the underlying parenchyma. Occasional stomata occur in the epicarp. The epicarp is the principal subject of this study.

There are few specific data on the histology of fruits of economic importance. Dorsey and Potter *(5)* studied the structure and development of the skin of the peach. They were particularly interested in the epidermal hairs and pointed out the great variation in this character from smooth nectarines to very "fuzzy" peaches, apricots lying between these two extremes. Curtis *(4)* gave good descriptions of the structure of the epidermis of Moorpark and of Royal apricots. He was interested in possible correlation between structure and resistance to brown rot. Addoms, Nightingale, and Blake *(1)* studied the development and ripening of peaches in correlation with physical characteristics, chemical composition, and histological structure of the fruit flesh. Tukey and Young *(11)* reported on the histology of the developing fruit of the sour cherry. Weier and Stocking *(13)* reviewed histological changes induced by processing, particularly by moist heat, in fruits and vegetables.

Consideration of the problem of tough frozen apricot skins, always raises the question: Are the skins really tougher in frozen than in fresh apricots or do they only appear to be so by contrast with the flesh, which becomes flabby as a result of freezing and thawing? These studies were undertaken to throw light upon this problem. The experiments included subjective taste testing, objective mechanical measurements of skin toughness, and histological studies of structure, development, and histochemistry of the skins.

EXPERIMENTAL

Penetrometer studies. *Methods.* Toughness was measured objectively by means of a mechanical penetrometer *(3)*. This device measured the relative weights required to penetrate pieces of skin tissue. A double layer of skin was placed upon a glass platform. When the motor was started, a weight traveled along a graduated arm; when the tissue had been penetrated, an electrical contact was made. The circuit was thus broken and the position of the weight was recorded. The readings should all have been comparable as long as the load was kept constant and the arm properly balanced at the zero position.

Observations. Penetrometer measurements made on fresh and frozen apricot skins after several storage periods are shown as histograms in Figure 1. The abscissas of these histograms represent the step intervals or ranges within which readings fell. The ordinates indicate the number of readings which fell within the particular step interval. The figures show that, with one exception, there was a general downward trend with time of storage in the means representing the load required to penetrate. The histogram for the fresh apricot skin shows a rather normal distribution; those for the frozen samples taken after the several storage periods were somewhat skewed. The sample which had been stored for 2 years had such a low average penetrometer value that the step intervals in the histogram were decreased.

Frozen apricot skins of 4 varieties were compared for toughness by penetrometer measurements after 9 months of storage with the following results: Royal, $1.02 \pm .34$; Tilton, $0.99 \pm .36$; Moorpark, $0.72 \pm .25$; C. Hesse's seedling No. D20-43, $1.37 \pm .49$.

Figure 2 presents histograms made from penetrometer measurements of the skins of canned apricots. These showed a steady decrease in toughness. The readings immediately after canning were the most variable, and the skins grew gradually more uniformly tender during storage.

All the penetrometer measurements were characterized by rather high standard deviations or variability. Some of this variability may possibly be brought about by local differences in cell wall composition resulting from minor bruising healed during growth and ripening—would not be readily visible externally—or by other factors difficult to recognize.

Organoleptic studies. Results of taste tests made by a number of experienced as well as by untrained judges in the laboratory agreed very closely with the objective appraisals made by the mechanical penetrometer as to relative texture of the canned

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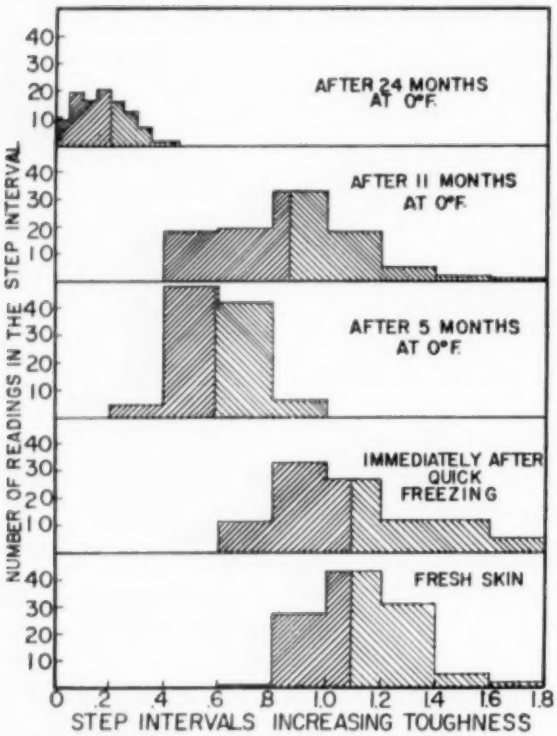
AFTER 24 MONTHS AT 0°F.
AFTER 11 MONTHS AT 0°F.
AFTER 5 MONTHS AT 0°F.
IMMEDIATELY AFTER QUICK FREEZING
FRESH SKIN
NUMBER OF READINGS IN THE STEP INTERVAL
STEP INTERVALS INCREASING TOUGHNESS

Figure 1. Distribution of penetrometer readings on frozen apricot skins.

and frozen samples. When fresh apricot skins were chewed and compared with the freshly frozen, there seemed to be little detectable difference between the two as far as actual absolute toughness is concerned. This agrees, in general, with the penetrometer data. However, there is a noticeable difference in the sensation which is produced by a fresh or a frozen apricot half. In the fresh fruit the underlying flesh and the skin adhere firmly together whereas in the frozen, the skin tends to slip away from the flesh so that the presence of the skin is considerably more noticeable in the frozen. Although we have not yet found an objective technique which is satisfactory for measuring the texture of the flesh before and after freezing, it seems very likely that the objectionable apparent toughness of the frozen apricot skin is explained mainly by this tendency of the skin to separate from the flesh instead of adhering firmly to it, and by the breakdown which occurs in the tender parenchyma cells of the flesh.

If apricots are frozen in slices rather than in halves, the objectionable texture of the skins is less noticeable [Joslyn *et al. (8)*]. This can probably be explained by the smaller size of the pieces of skin tissue in the sliced fruit.

It has frequently been observed that the vascular elements in frozen plant foods, especially in unblanched ones, become more noticeable than in the fresh. This is due to the mechanical strength of their cell walls, which permits them to retain their original shape. On the other hand, the types of cells with softer walls, characteristic of the main body of parenchyma tissues of the fruit flesh which in the fresh state are rigidly held by turgor and osmotic forces, break down as a result of freezing and thawing. Even though the penetrometer data indicated a gradual decrease in actual weight required to puncture the skin of the frozen fruit, the sensation or general impression upon tasting was still that the skin was tough; the canned, by contrast, was always tender to taste. The fresh does not "taste" or "feel" tough to chew because the flesh is turgid and firm and adheres tightly to the skin during mastication. Possibly measurements of the "chewing resistance" of fresh, frozen, and canned apricot skins and flesh would yield more reliable objective data. Suitable apparatus, such as that described by Volodkewish *(12)*, for such measurements, was not available.

Direct microscopic study of the skin. *Methods.* For histological studies, skins of fresh and processed apricots were slipped off or pared from the flesh and gently scraped to remove bits of adhering flesh. Sections were prepared by the paraffin method and stained with Delafield's hematoxylin [Johansen *(6)*]. Another method of preparation of skin samples was by clearing. For this the gently scraped skin was treated with a 5% sodium hydroxide solution at room temperature for several days to clear the tissues of as much as possible of the cell contents. The unlignified cell walls thus became translucent, making those cells with thick lignified walls more evident. Clearing was followed by washing, dehydrating, and staining of the pieces of skin with safranin, and mounting without sectioning.

Observations. In cross section, the frozen skin appeared normal; that is, the cell walls were definite and distinct. In contrast to this the skin of canned apricots in cross section appeared partially dissolved. This may be caused by the action of heat upon the heat labile cell wall constituents, such as pectic substances. The fresh skin was similar to the frozen. Thus it appears that microscopic structure may be correlated with texture as judged by organoleptic and objective means.

A photomicrograph (Figure 3) was made through a piece of cleared and stained apricot skin with the low power of the microscope. Definite vascular elements scattered throughout the skin may be seen. These are complex strengthening cells (called sclereids) which are known to occur at the ends of the veinlets of many leaves including those of the apricot, but are scattered also throughout various other types of tissues. The skin sclereids may be connected with the vascular system in the fruit flesh, or they may be independent idioblasts. Their discovery in the apricot skin was of considerable interest.

Histochemical studies. *Methods.* Histochemical studies were made of the fresh skin of the Royal apricot collected at Winters in the 1950 season. The tests used were those described by Johansen *(6)* and Rawlins *(9)*. Briefly they were the following: (a) For lignin, saturated phloroglucin in 18% HCl with a drop of concentrated HCl added at the time the test was made, gave a red color if lignin was present, or 1:10,000 methylene blue gave a greenish positive lignin test. (b) For hemicelluloses, alcoholic phloroglucin plus a drop of concentrated HCl added at

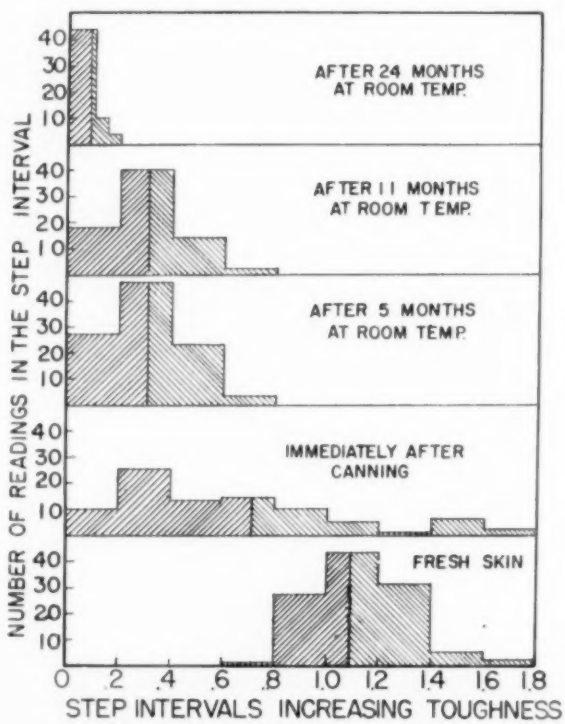
AFTER 24 MONTHS AT ROOM TEMP.
AFTER 11 MONTHS AT ROOM TEMP.
AFTER 5 MONTHS AT ROOM TEMP.
IMMEDIATELY AFTER CANNING
FRESH SKIN
NUMBER OF READINGS IN THE STEP INTERVAL
STEP INTERVALS INCREASING TOUGHNESS

Figure 2. Distribution of penetrometer readings on canned apricot skins.

Figure 3. Cleared portion of apricot skin showing vascular elements, including sclereid (107×).

the time the test was made, gave a red test. (c) For cellulose, zinc-chloroiodine gave a blue positive test. This was applied both before and after treatment with chlorine water and hot sodium sulfite to remove lignins. Methylene blue 1:10,000 stained cellulose blue. (d) For pectins a very dilute solution of ruthenium red gave a pink positive test. If lignins and celluloses were removed (the latter with Schweitzer's reagent) the pectins were more easily discernible by this procedure, or by staining purple or lavendar with methylene blue. (e) For cutin, addition of Sudan IV gave an orange color or zinc-chloroiodine gave a yellow.

Observations. By means of these tests it was established that the walls of the flesh and epidermal cells consisted of cellulose and pectin with an outer layer of cutin on the epidermis. The walls of the hypodermal cells were cellulose with a wide inner layer of pectin. The sclereids and vessels were predominantly lignin, with also some cellulose and pectins. The epidermal hairs were lignified at the base, while the hairs themselves stained splotchily for lignin, cellulose, and pectins. There were no apparent differences in wall substances in various regions of the fruit.

Developmental study. *Methods.* A developmental study of the apricot from blossom to mature fruit was made during the 1947 growing season, using a tree (probably of the Royal variety) growing in Berkeley, on the University's Oxford Tract. Although this is not a representative growing region, the fundamental developmental stages should be similar for all localities. Collections were made at approximately 10-day intervals throughout the growing season (122 days total from March 5 to July 5). At each collection either the entire fruit or representative portions not over ¼ inch thick in any direction, including the skin and underlying tissues, were deaerated and fixed in formol acetic acid ethyl alcohol fixative [Sass *(10)*]. When fixation was complete the samples were stored in 70% alcohol until the entire series was complete. Then they were prepared for sectioning by the paraffin method [Johansen *(6)*], sectioned, mounted, and stained with several staining schedules, and studied microscopically. Growth and differentiation (specialization of parts or organs), especially of the "skin," were noted at each stage.

Observations. The photomicrographs shown in Figures 4 through 9 represent cross sections of the skin and more or less of the underlying tissues at six stages of development.

The first collection was made when the blossom had just dropped. The developing ovary, or young fruit, was small enough to permit showing portions of the entire structure in Figure 4. The protective layer consisted of a single epidermal layer of cells from many of which epidermal hairs had already developed. In fact, at this young stage, the uninjured hairs were actually as long as the entire diameter of the fruit. Each epidermal hair was an outgrowth from a single cell. Most of the pericarp, immediately underlying the epidermis was made up of small isodiametric parenchymatous cells. The future stony endocarp region was differentiated just outside the young seed (kernel). At maturity the flesh included an anastomosis of small vascular strands, the beginnings of which could be seen in somewhat darker staining spots in the flesh at this stage.

In Figure 5 (22 days later) the fruit had already grown sufficiently so that only a portion of the flesh tissues and the skin could be shown with the same magnification as had been used previously. At this stage the skin was already differentiated. There was an hypodermal group, consisting of 3 or 4 cell layers beneath the epidermis. These cells were somewhat larger in diameter than the epidermal cells, and smaller than the parenchyma cells. The hypodermis and epidermis together constituted the skin. The vascular bundles in the flesh were very plainly visible.

In Figure 6 (12 days after the previous one) there were no very marked changes, except, perhaps an increase in average diameter of the flesh parenchyma cells.

In Figure 7 (18 days later) the most noticeable change was that the flesh parenchyma immediately below the hypodermis had grown so that the cells were of greater diameter, making them more distinct from the hypodermis.

In Figure 8 (20 days later) this same tendency had continued. The vascular strands continued to occur here and there throughout the flesh underlying the skin.

In all subsequent stages up to full maturity (50 days after Figure 8) the changes were in a similar direction, but slight. At maturity the cells immediately underlying the skin were rather

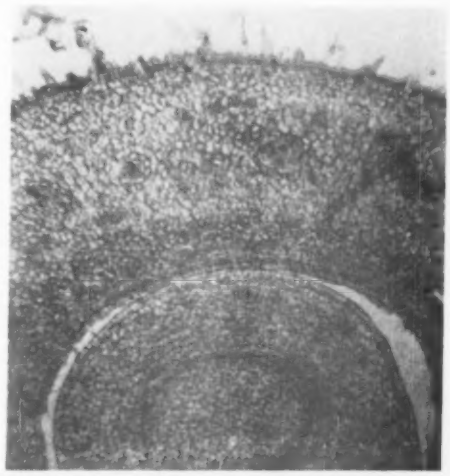

Figure 4. Cross section through apricot ovary right after dropping blossom (107×).

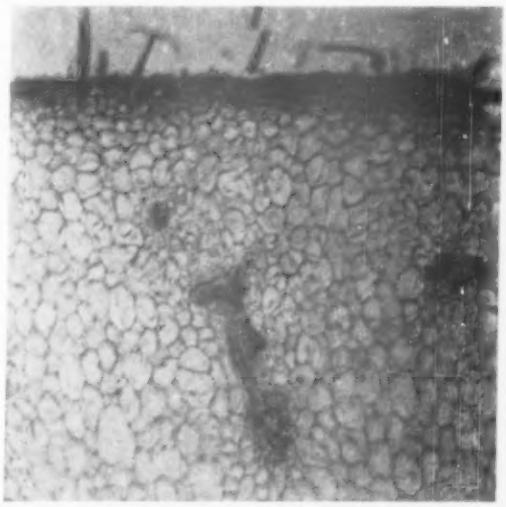

Figure 5. Cross section of a portion near surface of young developing fruit 22 days after blossom drop (107×).

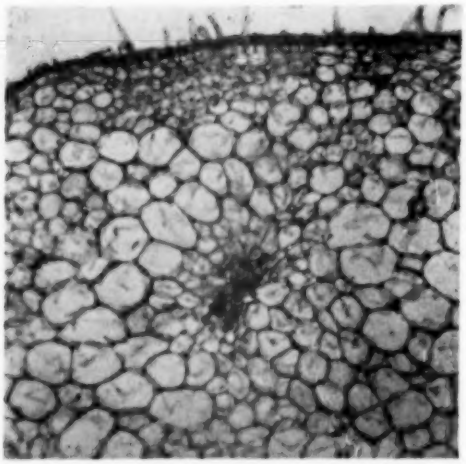

Figure 6. Cross section of a portion of developing apricot fruit, near surface, 34 days after blossom drop (107×).

Figure 7. Cross section of a portion near surface of young developing fruit 52 days after blossom drop (107×).

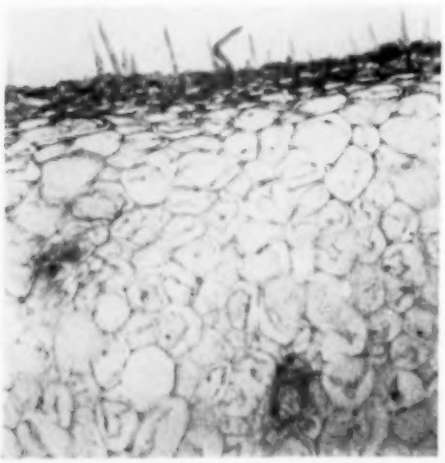

Figure 8. Cross section of a portion near surface of young developing apricot fruit 72 days after blossom drop (107×).

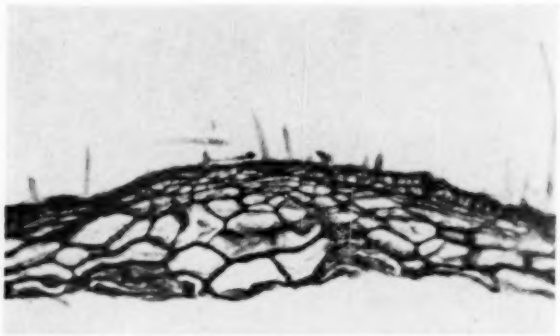

Figure 9. Cross section of mature apricot skin, 122 days after blossom drop (107×).

large and thin walled. Figure 9 shows a cross section of the mature skin alone, including the epidermis and hypodermis. Probably the hypodermis plays a more important role than the epidermis in the toughness of the skin. The lowest row of cells in this photomicrograph shows the relatively large diameter of the cells of the underlying parenchyma. These large cells are involved in the breakdown causing separation of the skin from the flesh, after freezing and thawing.

DISCUSSION

The evidence from the organoleptic, penetrometer, and histological studies presented, indicates that the skins of frozen apricots do not actually toughen, as a result of freezing preservation but that this effect is merely apparent because of the large size of the flesh parenchyma cells just below the hypodermis, which are easily broken as a result of freezing and thawing, causing the skin to separate from the flesh. In the canned apricot halves this effect is precluded by the tenderization of the epidermis and hypodermis resulting from heat processing. The cell wall materials of the canned apricot skins tend to swell and partially disintegrate, making the finished product (the canned apricot half) more acceptable than the frozen. The wide inner layer of pectin in the hypodermal cells observed in the histochemical studies probably accounted for this swelling during canning.

SUMMARY

Mechanical penetrometer studies of fresh, frozen, and canned apricot skins indicated that frozen skins were not actually tougher than fresh skins, but even grew less tough upon prolonged storage. Varietal differences in skin toughness of frozen apricot halves were also observed.

Organoleptic appraisal of the same material also indicated that the skin of the frozen fruit was not tougher than the fresh skin, but that the frozen skin was merely more prominent because it tended to separate from the flesh, which had lost its turgor after freezing and thawing.

Histological studies showed that the cell walls of the canned apricot skins had a swollen partially dissolved appearance, probably resulting from changes in the middle lamellae and cell walls brought about by heat. This might explain their greater tenderness as compared with the fresh and frozen skins.

The chemical constituents of the cell wall materials of the epidermal, hypodermal, vascular, and flesh cells were determined histochemically.

A developmental study of the skin from blossom to mature fruit showed that most of the tissues, except the hypodermis, present in the mature fruit had already been differentiated in the fruit soon after the blossom had dropped. The changes which took place were mainly growth and specialization of the cell wall material and cell shapes during maturation of the fruit. At maturity, the large relatively weak cell layers immediately underlying the hypodermis allow the breakdown which causes the characteristic skin sloughing of frozen apricot halves

Acknowledgments

The author wishes to express appreciation to Miss Mildred Boggs, Western Regional Research Laboratory, Albany, California, for her generous cooperation in arranging the use of the penetrometer, to Jane Magee, formerly of this Department, for making the histochemical tests, to Florence Pen, formerly of this Department, for other technical assistance, and to Erwin Strohmaier for assistance with the photomicrographs.

LITERATURE CITED

1. Addoms, R. M., Nightingale, G. T., and Blake, J. A. Development and ripening of peaches as correlated with physical characteristics, chemical composition, and histological structure of the fruit flesh. II. Histology and microchemistry. New Jersey Agri. Expt. Sta. *Bull. 507* (1930).
2. Bailey, L. H. *Manual of Cultivated Plants.* 1949, The Macmillan Co., New York, N. Y.
3. Candee, F. W., and Boggs, M. M. Apparatus for measuring the texture of cooked peas. *Western Canner and Packer*, 33, 44 (1941).
4. Curtis, K. M. The morphological aspect of resistance to brown rot in stone fruit. *Ann. Bot.*, 42, 39 (1928).
5. Dorsey, M. J., and Potter, J. S. A study of the structure of the skin and pubescence of the peach in relation to brushing. Illinois Agri. Expt. Sta. *Bull. 385* V. 27, 405 (1932).
6. Johansen, D. A. *Plant Microtechnique.* 1940, McGraw-Hill Book Co., New York, N. Y.
7. Joslyn, M. A., and Hoehl, L. A. The commercial freezing of fruit products. California Agri. Expt. Sta. *Bull. 703* (1948).
8. Joslyn, M. A., Jones, William L., Lambert, E., Miller, John, and Shaw, R. L. Studies of the application of sugar solutions with and without antioxidants. Part III. *Quick Frozen Foods*, 11 (No. 12) 43 (1949).
9. Rawlins, T. E. *Phytological and Pathological Research Methods.* 1933, John Wiley and Sons., New York, N. Y.
10. Sass, J. E. *Elements of Botanical Microtechnique.* 1940, McGraw-Hill Book Co., New York, N. Y.
11. Tukey, H. B., and Young, J. O. Histological study of the developing fruit of the sour cherry. *Bot. Gaz.*, 100, 723 (1939).
12. Volodkewish, N. N. Apparatus for measurements of chewing resistance or tenderness of food stuffs. *Food Research*, 3, 221 (1938).
13. Weier, T. E., and Stocking, C. R. Histological changes induced in fruits and vegetables by processing. *Advances in Food Research*, 2, 297 (1949).
14. Western Canner and Packer. *Statistical Yearbook Number*, 44 (6) 214 (1952).

Vitamin Retention in Peas and Lima Beans After Blanching, Freezing, Processing in Tin and in Glass, After Storage and After Cooking[a]

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Effects of current methods of preservation and of cooking on the vitamin retention in peas and lima beans are reported. Data on the retention of thiamine, riboflavin, niacin, ascorbic acid and carotene during a 12-month storage period are provided.

The scientific literature contains many references pertaining to factors influencing the nutritive value of fruits and vegetables. A considerable proportion relate to the effect of processing and of storage on the vitamin content of these foods. The series of studies recently sponsored by the National Canners Association-Can Manufacturers Institute *(2, 3, 6, 7, 8, 9, 11, 12, 13, 15, 20, 25, 28)* has been concerned primarily with factors which influence vitamin retention in fruits and vegetables during the canning operation and during subsequent storage of the processed foods. Investigations also have been carried out which have been concerned with some of the factors affecting the vitamin content of fruits and vegetables during their preparation for freezing, during freezing, and during frozen storage. The results of these studies often have varied owing to the numerous factors involved. Because of the variations in experimental techniques and in results it is difficult to evaluate the relative merits of the different methods of food preservation; i.e., freezing processing in tin, and processing in glass, from the standpoint of nutrient retention. Many studies of this type have involved different fruits and vegetables, fruits and vegetables from different sources and frequently of different variety and quality, and fruits and vegetables prepared and handled in different manners; hence the majority of data are not amenable to comparison. Because of this fact, it was believed that useful information would accrue from an investigation in which the fruits or the vegetables were from the same source, prepared in a uniform manner, frozen, processed in tin, processed in glass, stored under controlled conditions, and were subsequently assayed at regular intervals for their vitamin content both before and after applying a uniform cooking procedure. The inclusion of the effect of cooking in such a study is of utmost importance in that the nutritive value of the foods preserved by the different procedures may be affected differently by cooking, and the percentages of the original nutrients which reach the plate of the consumer is an important consideration

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in evaluating the effectiveness of the several methods of preservation.

The data reported at this time were obtained in the course of such an investigation in which peas and lima beans were the foods under study.

EXPERIMENTAL

The procedures followed in the investigation were: (a) an adequate and uniform lot of each of the vegetables to be studied were obtained from known sources; (b) the vitamin content of the fresh vegetables both before and after being cooked by a uniform cooking procedure was determined; (c) the blanched vegetables were preserved by freezing, by processing in tin, and by processing in glass; (d) the preserved vegetables were stored for one year under customary conditions of storage; and (e) the change in the vitamin content of the preserved vegetables was determined by appropriate analyses at definite intervals during the storage period. Inasmuch as a great amount of analytical work was anticipated only *2* vegetables were selected for study at this time. Peas and lima beans were chosen because both are widely used in the American dietary and are preserved in large quantities by freezing and by canning.

Fancy grade Teton peas and Clark's bush lima beans were obtained in season in 150-pound lots from a local cannery. The freshly harvested vegetables were vined, washed, placed in enamel-lined containers, covered with chipped ice, and brought to the laboratory. After being drained and hand picked to remove chipped ice, pods, etc., *25*-pound batches of the vegetables were suspended in cheesecloth, blanched at 93° C. (200° F.) in *25* gallons of water, cooled in iced water, drained for *3* minutes and reweighed in order to determine weight losses during blanching. The several batches of the blanched vegetables were combined and thoroughly mixed preliminary to freezing and canning. The peas were blanched for *3* minutes and the lima beans for 5 minutes.—

Freezing of vegetables. Three-hundred g. portions of the blanched vegetables were placed in heavily-waxed cubical cardboard containers preliminary to freezing. This quantity of the vegetables permitted approximately one-fourth inch head space. The cartons were sealed and the vegetables frozen in a small chest-type of freezer,[b] in which the temperature ranged from —30° to —32° C. (—22° to —26° F.) during the 48-hour period following the placing of the food in the freezer. The frozen vegetable was stored in a similar type of freezer and at no time during the storage period was the storage temperature observed to be above —23° C. (—10° F.).

Processing in tin. Four 100-gram portions of the blanched vegetables were placed in No. *2* tins, 200 g. of hot brine (*2%* of sodium chloride in distilled water) added. The containers were closed in an automatic closing machine, and then processed in an experimental-type of retort at 116° C. (240° F.). This quantity of the vegtables permitted approximately one-fourth inch headspace. The peas were packed in plain tins and processed for 35 minutes while the lima beans were packed in C-enameled tins and were processed for 45 minutes. At the completion of the processing, the contents of the retort were cooled by means of cold water, the tins wiped dry, and then stored on shelves in a small darkened room in which the annual temperature variation ranged from 20° to 29° C. (68° to 85° F.).

Processing in glass. Three 100-gram portions of the blanched vegetables were placed in pint-size glass jars (similar to those used in home-canning), the hot brine added (*2%* of sodium chloride in distilled water), the jars closed by means of screw caps and rubber gaskets, placed in the retort and processed at 116° C. (240° F.) One hundred and fifty g. of the brine was used with the peas and 175 g. was added to the lima beans. The peas were processed for 35 minutes and the lima beans for 45 minutes. The vegetables processed in glass were allowed to cool gradually in the retort, the lids of the containers tightened, and then the processed product was allowed to stand at room temperature until cool. When cool, the vegetables processed in glass were stored under the same conditions as those processed in tin.

[b] Courtesy of Sears, Roebuck and Company.

Cooking of vegetables. Weighed quantities of the vegetables were cooked over an electric hot-plate and in quart-size enameled kettles having tightly-fitting enameled lids except at a small convex pouring lip which served as a steam escape.

In cooking the fresh vegetables, a 300-gram portion of the product was added to 150 g. of boiling salted water (*2%* solution of sodium chloride in distilled water), the lid placed on the kettle, the contents brought to a boil and boiled gently for *25* minutes. The liquid was drained from the cooked vegetable and the liquid and solids weighed separately. Distilled water was added to compensate for weight losses during cooking owing to the escape of water vapor.

In cooking the frozen vegetables, a 300-gram portion from the combined contents of *2* cartons of the frozen product was poured into 150 g. of briskly boiling salted water (*2%* sodium chloride in distilled water), the lid placed on the kettle and the cooking continued for 5 minutes after the contents of the kettle returned to the boiling temperature. At the end of the cooking period, the procedure following was the same as that employed with the cooked fresh vegetable.

Vegetables processed in tin containers and those processed in glass containers were cooked in essentially the same manner. The contents from *2* containers were drained on heavily tinned screens for *2* minutes and the solids and liquid weighed separately. Three-hundred g. of the solids constituted a sample. In the instance of peas, a proportional part of the liquid drained from the processed vegetable was heated to boiling in a covered kettle, the peas were then added and the heating continued until the contents of the kettle had resumed boiling and had boiled for 10 minutes. Here again weight losses were compensated for by the addition of distilled water. During the processing of lima beans all of the brine was absorbed by the vegetable with the formation of a jelly-like consistency which made it impossible to separate solids from liquid. Therefore, in cooking the processed lima beans, a 300 gram portion of the composited contents from *2* containers were added to 150 g. of boiling distilled water in a covered kettle and the content of the kettle brought to boiling and boiled for 10 minutes. Weight loss during cooking was compensated for by addition of distilled water. In each instance the solids and liquids from the cooked vegetable were recombined in the proper proportions to form the sample for vitamin assay.

Sampling for vitamin analysis. Representative samples were taken from large lots of the fresh and blanched vegetables for the cooking tests and for vitamin analyses. Samples of the preserved vegetables were taken from the combined contents of at least *2* containers. These samples were taken for the cooking tests and for vitamin analyses immediately after freezing or processing and again after 1, *2*, *3*, 4, 5, 6, 9, and 12 months of storage.

Vitamin assays. Procedures followed in assaying for the various vitamins were those which have been widely used in studying the nutritive value of vegetables. All determinations were carried out in duplicate and re-assays were made on those samples yielding questionable vitamin values. The data reported represent the average value of *2* or more determinations and are expressed in terms of the percentage retention or loss of the respective vitamins based on the vitamin content of the fresh unblanched vegetables. Ascorbic acid (reduced form) was determined by direct titration with a standard solution of 2,6-dichlorobenzenoneindophenol. In preparing the vegetable extracts for assay, weighed quantities of the vegetables were pureed by blending for *3* minutes in a Waring blendor with an equal weight of 6% metaphosphoric acid solution ,the blending being carried out in an atmosphere of nitrogen. In preparing samples of the vegetables for assay for thiamine, riboflavin, and niacin, definite weights of the vegetables were blended for *3* minutes in an equal weight of 0.1 N sulfuric acid to which had been added 1 ml. of chloroform. The blended samples were transferred to pint-size glass jars, layered with *2* ml. of toluene and stored under refrigeration until assayed. Thiamine was determined by the thiochrome method essentially as outlined by Conner and Straub *(4)*. Riboflavin was determined by a modification *(24)* of the microbiological method of Snell and Strong *(21)*. Niacin was determined by the microbiological method of Snell and Wright *(22)*, using the basal medium suggested by Krehl, Strong, and Elvehjem *(14)*.

The samples of vegetables used in the carotene determination were prepared for assay and preserved by blending for 3 minutes weighed quantities of the vegetables with an equal weight of a 1% alcoholic solution of potassium hydroxide and storing the resulting puree under refrigeration until assayed. The assay was carried out essentially as outlined by Moore and Ely *(17)*, using petroleum ether as the solvent, sodium sulfate as the dehydrating agent, and dicalcium phosphate in the chromatographic columns. Concentrations of carotene in the eluates were measured at 450 mμ using a Beckman Quartz spectrophotometer. All vitamin values were first calculated on the basis of micrograms or milligrams of vitamin per 100 g. of the original vegetable and then in terms of the percentage retention or percentage of vitamin lost.

RESULTS

The data obtained during the course of the studies have been summarized and typical data are presented in Tables 1 and 2.

DISCUSSION

Typical data relating to the vitamin content of the peas and lima beans as influenced by blanching, preservation and by cooking have been summarized and are presented in Table 1.

It is to be noted from these data that each vegetable lost approximately one-third of its original ascorbic acid content during blanching. This magnitude of vitamin loss is within the range reported as resulting from the commercial blanching of the two vegetables *(5, 7, 8, 10, 15, 16, 28)*. This marked decrease in ascorbic acid content is due to the combined effects of loss of the vitamin through solution in the blanching water and through the destruction of the vitamin, perhaps through oxidation. Since the 2 vegetables used in these studies were in the early stage of maturity it is highly probable that shorter blanching periods would have proved adequate from the standpoint of enzyme inactivation and might have resulted in smaller losses of ascorbic acid.

Both vegetables sustained further losses of the vitamin during the time required for packaging and for freezing. The peas lost 12% and the lima beans lost 18% of their original ascorbic acid content during this period. Blanched peas processed in tin and those processed in glass lost approximately 20% of their original ascorbic acid content during packaging, processing, and cooling, whereas the blanched lima beans lost approximately 30% of their content of this vitamin under corresponding conditions.

The subsequent loss of ascorbic acid from the vegetables processed in glass and stored for 12 months was considerably greater than from the vegetables processed in tin and stored for the same period under similar conditions. Loss of ascorbic acid from the frozen peas during the 12-month storage period was approximately 20% whereas the frozen lima beans sustained a smaller loss of the vitamin during that period. The loss of ascorbic acid from peas and from lima beans processed and stored in tin was of the same relative magnitude as those reported for the commercially processed vegetables *(1, 7)*.

The loss of ascorbic acid during the cooking of the vegetables following a 12-month storage period ranged from 1% for the processed-in-glass lima beans to 24% for the frozen lima beans. The loss of the vitamin during the cooking of the peas after 12 months of storage ranged from 13% to 18%. It is to be noted that the losses of ascorbic acid during cooking were not due to leaching inasmuch as the samples used for vitamin analyses contained both the solids and liquid. The overall loss of ascorbic acid from peas during blanching, freezing or processing, storage, and cooking amounted to 80, 82, and 94%, respectively, for the frozen vegetable, for the vegetable processed-in-tin, and for the vegetable processed-in-glass, whereas the corresponding losses of the vitamin from the lima beans were 88, 92, and 95%, respectively. Although the total loss of ascorbic acid following each type of preservation seemed considerable, it was of interest to note that unblanched peas, frozen and stored under comparable conditions, retained only 25% of their original ascorbic acid after 12 months of storage and only 14% after subsequent cooking. Hence the peas blanched before freezing retained more ascorbic acid after 12 months of frozen storage than did the unblanched peas and the latter were no longer usable because of poor quality. The loss of ascorbic acid during cooking seemed to vary somewhat with the particular vegetable and also with the previous treatment of the respective vegetable. The average loss of the vitamin from the peas during 13 different cooking tests was 18.5% and from the lima beans was 15.7% of the original ascorbic acid content.

Data relative to the retention of ascorbic acid, thiamine, riboflavin, niacin, and carotene by peas and of ascorbic acid, thiamine, riboflavin, and niacin by lima beans after blanching, after freezing or processing in tin or in glass, after storage for different periods, and subsequently after cooking are presented in Table 2. Since the initial analysis of the lima beans indicated a low carotene content and since marked losses of carotene do not usually result from the various experimental conditions employed, further carotene analyses were not made on this vegetable. Although the vegetables

TABLE 1

The vitamin content of peas and lima beans as affected by blanching, by processing and by cooking

Description of vegetable	Peas					Lima beans			
	Percent retention[a]					Percent retention[a]			
	Ascorbic acid	Thiamine	Riboflavin	Niacin	Carotene	Ascorbic acid	Thiamine	Riboflavin	Niacin
Fresh, uncooked	100	100	100	100	100	100	100	100	100
Fresh, cooked	81	93	108	93	78	48	78	103	95
Fresh, blanched	67	95	81	99	102	64	68	82	74
Blanched, frozen	55	94	78	76	102	46	62	77	77
Blanched, frozen, cooked	38	63	72	79	103	32	64	88	80
Blanched, processed in tin	47	52	95	76	105	28	42	82	83
Blanched, processed in tin, cooked	27	55	89	70	117	15	33	88	80
Blanched, processed in glass	46	63	85	73	114	33	58	74	77
Blanched, processed in glass, cooked	25	40	84	72	113	21	49	84	71

[a] Based on the vitamin content of the fresh washed vegetable.

were subjected to vitamin analyses at more frequent intervals, data are reported only for the 0, 3, 6, and 12 months' storage period.

An inspection of the data presented in Table 2 reveals that, of the 5 vitamins for which assays were made, ascorbic acid was most adversely affected by blanching, by freezing, by processing, by storage and by cooking. On the other hand, carotene was least adversely affected by each of these experimental conditions. In fact there were numerous instances in which an apparent increase in carotene content resulted from blanching, from processing, and from cooking, and there were a few instances in which the carotene content appeared to increase as the result of storage. Similar observations relative to increases in carotene content have been noted previously *(5, 7, 8, 10, 15, 29)*. This anomaly may be attributed to a number of factors among which are: (a) good stability of the carotene under the conditions involved, (b) loss of non-carotenoid solids during the blanching and washing, and (c) increase in the extractibility of the carotenoid pigments as the result of processing, of storage, and of cooking. Another apparent anomaly observed in the present studies indicated that cooked frozen lima beans frequently indicate a higher thiamine, riboflavin, and niacin content than do the uncooked beans. However, it is believed that the slightly higher vitamin values observed are due to the increased extractibility of the vitamins from the cooked vegetable.

Loss of thiamine from both peas and lima beans as the result of blanching was less than the loss of ascorbic acid. As has been previously reported in connection with the preservation of peas *(18)*, no marked loss of thiamine resulted from freezing. On the other hand lima beans did lose a measurable amount of thiamine during freezing and sustained additional losses during frozen storage. Furthermore, processing in tin and in glass, and also subsequent cooking did affect adversely the thiamine content of both vegetables. Increasing the storage period from 0 to 12 months resulted in a further loss of thiamine from the vegetables. Peas, blanched, then frozen or processed in tin or processed in glass, then stored for 12 months and subsequently cooked retained 52, 34, and 30%, respectively, of their original thiamine content, whereas lima beans, under similar experimental conditions, retained 45, 16, and 16%, respectively.

Both peas and lima beans lost approximately 20% of their riboflavin content during blanching, but there was essentially no loss of this vitamin during freezing or during processing. Twelve months of storage resulted in a slight loss of riboflavin from frozen peas whereas those peas processed-in-tin and those processed-in-glass lost 30 and 35%, respectively, of the vitamin when stored for 12 months at room temperature. The lima beans which had been processed in glass sustained the greatest loss of riboflavin during storage. Cooking of the 2 vegetables resulted in only small additional losses of the vitamin. Peas which had been blanched, frozen, processed in tin, or processed in glass, stored for 12 months and then cooked, retained 72, 59, and 53%, respectively, of their original riboflavin content whereas lima beans under similar experimental conditions retained 53, 51, and 50%, respectively, of this vitamin.

Niacin retention was reasonably good under all experimental conditions. Peas lost 10% of their niacin content during blanching whereas lima beans lost 26%. Loss of niacin during freezing or during processing did not exceed 20%. Loss of this vitamin during 12 months of storage ranged from 0 to 21% and was somewhat less from the pea than from the lima beans. Both vegetables sustained only small losses of niacin when the fresh or blanched product was frozen, processed, or cooked. Peas which had been blanched, frozen, processed in tin, or processed in glass, stored for 12 months, and then cooked, were found to have retained 81, 69, and 73%, respectively, of their original niacin content whereas

TABLE 2

Vitamins retained by peas and by lima beans, after blanching, after freezing, after being processed in tin and in glass, after storage, and after cooking. (Retention based on the vitamin content of fresh, washed vegetable)

Vitamin	In the fresh vegetable	After blanching	Frozen				Processed in tin				Processed in glass			
			Months in storage				Months in storage				Months in storage			
			0	3	6	12	0	3	6	12	0	3	6	12
Peas—before cooking	*Mg./100 gm.*	%	%	%	%	%	%	%	%	%	%	%	%	%
Ascorbic acid	34.40	67	55	48	53	33	47	35	42	36	46	35	34	19
Thiamine	.28	95	94	94	94	79	52	41	38	38	63	38	34	35
Riboflavin	.12	81	78	58	67	72	95	54	61	65	85	65	62	50
Niacin	1.91	90	76	84	82	80	70	73	68	70	73	82	81	70
Carotene	.41	102	102	108	112	107	102	116	109	125	114	126	116	123
Peas—after cooking														
Ascorbic acid	19.90		38	31	32	30	27	21	19	18	25	13	11	6
Thiamine	.26		63	58	58	52	55	41	39	34	40	36	34	30
Riboflavin	.13		72	60	68	72	89	50	65	59	84	64	54	53
Niacin	1.77		79	88	90	81	70	72	69	69	72	82	76	73
Carotene	.32		103	124	115	112	117	108	122	122	113	106	115	123
Lima beans—before cooking														
Ascorbic acid	11.90	64	46	50	45	36	28	28	23	20	33	22	18	6
Thiamine	.27	68	62	59	63	45	42	34	29	19	38	27	26	19
Riboflavin	.07	82	77	80	77	82	85	62	72	42	74	68	65	50
Niacin	1.22	74	77	74	69	57	83	71	64	62	77	75	63	61
Lima beans—after cooking														
Ascorbic acid	5.66		42	23	27	12	15	13	10	8	21	12	8	5
Thiamine	.21		64	63	57	45	33	32	32	16	49	28	25	16
Riboflavin	.08		88	71	71	53	88	63	64	51	84	63	60	50
Niacin	1.16		80	78	70	65	80	78	68	58	71	74	62	57

lima beans, under similar experimental conditions, retained 65, 58, and 57%, respectively, of this vitamin.

It is recognized that perhaps the particular cooking procedure employed is not extensively used in connection with the preparation of these vegetables for table use. It is not claimed that the procedure is conducive to maximum retention of the various vitamins. It is believed, however, that the cooking procedure is representative of many of those in current use. Perhaps, also, it is less conducive to vitamin losses than were the cooking procedures used in some investigations the results of which have been previously reported *(11, 12, 19, 23, 26, 27)*.

SUMMARY

A study was made of the comparative effects of some of the current methods of vegetable preservation and of cooking on vitamin retention in peas and in lima beans. Blanching, freezing, canning in tin, and canning in glass were the preservation processes investigated. At monthly intervals during a 12-month storage period analyses were made by accepted methods of assay for ascorbic acid, thiamine, riboflavin, niacin, and for carotene.

Of the vitamins studied, ascorbic acid retention was most adversely affected by blanching, whereas carotene retention was least affected by this treatment. The blanched vegetables retained essentially the same percentages of thiamine, riboflavin, and niacin but retention of these vitamins was considerably higher in peas than in lima beans, perhaps due to the longer blanching time employed with the latter vegetable.

Further loss of ascorbic acid resulted from freezing whereas the other vitamins were not adversely affected by this treatment.

Processing in tin and in glass resulted in further loss of ascorbic acid and of thiamine, but retention of riboflavin, niacin, and carotene during processing was reasonably satisfactory. Following 12 months of storage, somewhat smaller losses of ascorbic acid were observed in the vegetables processed in tin than in those frozen or processed in glass.

Retention of thiamine and riboflavin in both vegetables decreased slightly with increase in storage time, whereas niacin and carotene retention remained satisfactory.

Significant losses of ascorbic acid and thiamine resulted from cooking but this treatment did not adversely effect retention of riboflavin, niacin, or carotene.

Peas or lima beans, blanched, then frozen or processed in tin or in glass, stored for 12 months, and then cooked, retained approximately $^2/_3$ of their riboflavin and niacin, $^2/_5$ of their thiamine, and about $^1/_5$ of their original ascorbic acid content. Retention of these vitamins in peas was more satisfactory following the various treatments than retention in lima beans. Carotene retention in peas was satisfactory under all conditions.

From the viewpoint of the vitamin content of the 2 vegetables when they were ready for the plate of the consumer, after 12 months of storage under conventional conditions, there did not appear to be any marked advantages attributable to method of preservation, frozen storage, processed in tin, or processed in glass.

LITERATURE CITED

1. Alexander, O. B., and Feaster, J. F. Thiamin and ascorbic acid values of raw and canned peas. *Food Research*, **12**, 468 (1947).
2. Brush, Miriam K., Hinman, Winifred F., and Halliday, Evelyn G. The nutritive value of canned foods. V. Distribution of water-soluble vitamins between solid and liquid portions of canned vegetables and fruits. *J. Nutrition*, **28**, 131 (1944).
3. Cameron, E. J., Pilcher, R. W., and Clifcorn, L. E. Nutrient retention during canned food production. *Am. J. Public Health*, **39** (6) (1949).
4. Conner, R. T., and Straub, G. J. Determination of thiamin by the thiochrome reaction. *Ind. Eng. Chem., Anal. Ed.*, **13**, 380 (1941).
5. Feaster, J. F., Mudra, A. E., Ives, Margaret, and Tompkins, Mardelle D. Effect of blanching time on vitamin retention in canned peas. *Canner*, January 8, 1949.
6. Guerrant, N. B., Vavich, M. G., and Dutcher, R. A. Nutritive value of canned foods. Influence of temperature and time of storage on vitamin content. *Ind. Eng. Chem.*, **37**, 1240 (1945).
7. Guerrant, N. B., Vavich, M. G., Fardig, O. B., Dutcher, R. A., and Stern, R. M. Nutritive value of canned foods. Changes in the vitamin content of foods during canning. *J. Nutrition*, **32**, 435 (1946).
8. Guerrant, N. B., Vavich, M. G., Fardig, O. B., Ellenberger, H. A., Stern, R. M., and Coonin, N. H. Nutritive value of canned foods. Effect of duration and temperature of blanch on vitamin retention by certain vegetables. *Ind. Eng. Chem.*, **39**, 1008 (1947).
9. Guerrant, N. B., Fardig, O. B., Vavich, M. G., and Ellenberger, H. A. Nutritive value of canned foods. Influence of temperature and time of storage of vitamin contents. *Ind. Eng. Chem.*, **40**, 2258 (1948).
10. Herrelein, D. G., Ptak, L. R., Metroff, S., and Clifcorn, L. E. Quality and nutritive value of peas as affected by blanching. *Food Technol.*, **4**, 109 (1950).
11. Hinman, Winifred F., Brush, Miriam K., and Halliday, Evelyn G. The nutritive value of canned foods. VI. Effect of large-scale preparation for serving on the ascorbic acid, thiamin, and riboflavin of commercially canned vegetables. *J. Am. Dietet. Assoc.*, **20**, 752 (1944).
12. Hinman, Winifred F., Brush, Miriam T., and Halliday, Evelyn G. The nutritive value of canned foods. VII. Effect of small-scale preparation on the ascorbic acid, thiamin, and riboflavin content of commercially canned vegetables. *J. Am. Dietet. Assoc.*, **21**, 7 (1945).
13. Ives, Margaret, Wagner, J. R., Elvehjem, C. A., and Strong, F. M. The nutritive value of canned foods. III. Thiamin and niacin. *J. Nutrition*, **28**, 117 (1944).
14. Krehl, W. A., Strong, F. M., and Elvehjem, C. A. Determination of nicotinic acid. *Ind. Eng. Chem., Anal. Ed.*, **15**, 471 (1943).
15. Lamb, F. C., Pressley, Anne, and Zuch, T. Nutritive value of canned foods. XXI. Retention of nutrients during the commercial production of various canned fruits and vegetables. *Food Research*, **12**, 273 (1947).
16. Lamb, F. C., Lewis, L. D., and Lee, S. K. Effect of blanching on the retention of ascorbic acid and thiamine in peas. *Western Canner and Packer*, May 1948.
17. Moore, L. A., and Ely, R. Extraction of carotene from plant material: a rapid quantitative method. *Ind. Eng. Chem., Anal. Ed.*, **13**, 600 (1941).
18. Moyer, James C., and Tressler, Donald K. Thiamin content of fresh and frozen vegetables. *Food Research*, **8**, 58 (1943).
19. Oser, Bernard L., Melnick, Daniel, and Oser, Mona. Influence of cooking procedure upon retention of vitamins and minerals in vegetables. *Food Research*, **8**, 115 (1943).
20. Pressley, Anne, Ribner, Clara, Smith, M. C., and Caldwell, Emily. The nutritive value of canned foods. II. Ascorbic acid and carotene or vitamin A content. *J. Nutrition*, **28**, 107 (1944).
21. Snell, E. E., and Strong, F. M. A microbiological assay for riboflavin. *Ind. Eng. Chem., Anal. Ed.*, **11**, 346 (1939).
22. Snell, E. E., and Wright, L. D. A microbiological method for the determination of nicotinic acid. *J. Biol. Chem.*, **139**, 675 (1941).
23. Southerland, Claire Kercher, Halliday, Evelyn G., and Hinman, Winifred E. Vitamin retention and acceptability of fresh vegetables cooked by four household methods and by an institutional method. *Food Research*, **12**, 496 (1947).
24. Stokes, J. L., and Martin, B. B. Influence of buffer and glucose in the *Lactobacillus casei* assay for pantothenic acid. *J. Biol. Chem.*, **147**, 483 (1943).
25. Thompson, Mary Louise, Cunningham, Elizabeth, and Snell, E. E. The nutritive value of canned foods. IV. Riboflavin and pantothenic acid. *J. Nutrition*, **28**, 125 (1944).
26. Van Duyne, Francis O., Chase, Jean T., Fanska, Janet R., and Simpson, Jean I. Effect of certain home practices on the reduced ascorbic acid content of peas, rhubarb, snap beans, and spinach. *Food Research*, **12**, 439 (1947).
27. Van Duyne, Francis O., Chase, Jean T., Owen, Royne F., and Fanska, Janet R. Effect of certain home practices on riboflavin content of cabbage, peas, snap beans, and spinach. *Food Research*, **13**, 162 (1948).
28. Wagner, J. R., Strong, F. M., and Elvehjem, C. A. Nutritive value of canned foods. Effect of blanching on the retention of ascorbic acid, thiamine, and niacin in vegetables. *Ind. Eng. Chem.*, **39**, 990 (1947).
29. Zscheile, F. P., Beagle, B. W., and Kraybill, H. R. Carotene content of fresh and frozen green vegetables. *Food Research*, **8**, 299 (1943).

The Determination of Volatile Reducing Substances (V. R. S.) as an Aid in Quality Control of Fish Products[a]

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The concept of quality is discussed from two points of view; namely, the distinction between an acceptable or wholesome product and one that is not, and the extent to which a given commodity meets some ideal condition or standard. Illustrative data have been presented showing the possible application of the determination of the content of volatile reducing substances as an aid in evaluating the aforementioned aspects of quality. Data for the content of volatile nitrogen compounds have also been included.

Quality is a term frequently employed but difficult to define. Quality seems not only to have different meanings for different people but also has various frames of reference. Since the quality of fish products, a subject on which attention has been focussed in the past and must continue to be in the future, is a problem that must be tackled at every stage of operations in the fishing industry, a means of distinguishing quality readily and quickly is of the utmost value.

In this paper two of the several possible interpretations of the significance of quality will be employed; namely (a) quality as the distinction between acceptable and not acceptable products, that is to say, products which *are* or *are not* wholesome and fit for consumption by man or animal, and (b) quality as a measure of the extent to which a given commodity compares with an ideal standard.

These two meanings probably overlap, since they both can be regarded as opposite ends of a scale of values or characteristic properties sought in a commodity. In the present treatment, however, these two aspects of quality are discussed separately. The possible application of the volatile reducing substances (V. R. S.) procedure to the problem of quality evaluation is discussed by means of illustrative data for various kinds of fish and fish products.

QUALITY AS A MEASURE OF WHOLESOMENESS

The evaluation of that phase of quality which is based on the determination of the wholesomeness or fitness for use of fish products has received much attention. Many methods for achieving this have been proposed but their success has varied. In this laboratory the effectiveness of a number of methods as indicators of the state of freshness of fish and fish products has been investigated for quite some time. None of the hitherto proposed or recommended methods has proven of general applicability and usefulness.

The procedure developed in this laboratory is based on the determination of the content of volatile reducing substances as the measure of the odor and hence of the condition of a sample *(4)*. With this method a close correlation between the chemical value and the organoleptic judgment has been obtained and a reliable evaluation of the state of preservation of fish samples can be made. A review of previously proposed methods and of the application of the determination of the content of volatile reducing substances to the problem of fish spoilage has already been published *(3)*. Some more general applications of the V. R. S. procedure to food commodities other than fish have also been described *(2)*. The details of the method will be found in the above-cited papers *(2, 4)* and hence in this paper data are confined to those that show the applicability of the V. R. S. method to the determination of the wholesomeness of a variety of raw and canned fish taken from commercial channels, in contrast to the largely experimental nature of the samples previously used *(3)*.

Table 1 shows data obtained from 2 batches of ground raw rock cod, on which V. R. S. and volatile nitrogen determinations were made. All volatile nitrogen determinations were made by the micro diffusion technique of Conway *(1)*. The marked correlation between the organoleptic and chemical judgments is evident, including the volatile nitrogen compounds. In Table 2

TABLE 1

Volatile reducing substances and nitrogen compounds in ground raw rock cod

Organoleptic condition	V. R. S.	Volatile nitrogen per 100 ml. press juice	
	micro-equivalents reduction per 5 ml. press juice	Total	Trimethylamine
Fairly fresh, passable odor	16.0	5.5	0
Sickening sweet off odor, not passable	53.4	20.2	4.8

TABLE 2

Volatile reducing substances and nitrogen compounds in frozen Dover sole fillets

Organoleptic condition	V. R. S.		mg. volatile nitrogen per 100 ml.	
	Range	Average	Total	Trimethylamine
Generally passable, none with off odor	4.0- 4.2	4.1	3.4	0
Generally fairly passable, some fillets wih slight off odor	9.3-19.0	15.2	11.0	3.1
Mixed fillets, some passable and some with off odors	13.9-22.6	18.2	12.4	4.5
Mixed fillets, some passable and many with definite off odors	11.8-32.7	21.3	19.0	8.0
Definite off odors, not passable	29.6-53.8	39.4	29.2	18.8

are shown values for V. R. S. and volatile nitrogen compounds in a series of batches of frozen raw Dover sole fillets in various states of preservation. The progressive increase in V. R. S. content and volatile nitrogen compounds with spoilage is marked and quite definite. Samples from a pack of chum salmon canned after increasing storage periods at an average temperature of 65° F. in the raw state in the round were obtained through the courtesy of the Northwest Branch Laboratory of the National Canners Association in Seattle, Washington. The results of the examination of these samples are shown in Table 3. The marked progression of the V. R. S. values with storage time is noteworthy. The organoleptic judgments paralleled the chemical findings. However, some difficulty was experienced in organoleptically distinguishing fish stored 7 and 31 hours from those stored 31 and 55 hours, respectively, whereas V. R. S. values increased progressively with the post mortem age of the

[a] Based on a paper presented at the Thirteenth Annual Meeting of the Institute of Food Technologists, June 21, 1953, at Boston, Massachusetts.

fish. In Table 4 are shown values for V. R. S. content and volatile nitrogen compounds in some California canned fish samples. It will be noted that there was a correlation between the V. R. S. values and the organoleptic findings, in contrast to the absence of any for the volatile nitrogen compounds.

TABLE 3

Volatile reducing substances in chum salmon canned after progressive raw storage in the round at 65° F. (18.3° C.) average temp.

Hours old	Organoleptic judgment	Volatile reducing substance	
		Range	Average
7	Normal odor and color	14.0–15.3	14.6
31	Slightly soft and pink, somewhat stronger odor	27.0–30.9	28.6
55	Somewhat soft, definite pink color and strong odor, stale	31.8–35.9	34.3
77	Soft, pink to red color, spoiled odor, taint	51.5–61.9	57.2
99	Honeycomb present, very strong spoiled odor, putrid	97.4–136.0	120.8

TABLE 4

Volatile reducing substances and nitrogen compounds in canned fish

Product	Organoleptic condition	V. R. S. Average	mg. volatile nitrogen per 100 ml.	
			Total	Trimethylamine
Calif. sardines in tomato sauce	Passable	23.7	44.3	6.5
	Not passable	61.4	33.7	2.8
Calif. anchovies in tomato sauce	Passable	31.6	58.2	19.3
	Not passable	43.3	58.5	18.7

QUALITY IN RELATION TO AN IDEAL STANDARD

The preceding examples were of instances in which the V. R. S. test was applied with the object of distinguishing acceptable from not acceptable fish, a commonly used interpretation of quality. The following examples are intended to illustrate the possibilities of its application as a means of establishing a quality gradient for edible samples, particularly where possible improvement in an already acceptable commodity is the goal. Methods of use in evaluating this phase of quality control have not received the attention the other aspect has. In order to call attention to the usefulness of the V. R. S. method for this purpose, some data for canned tuna are given, all samples being fit for use. In examining tuna samples by organoleptic means the criterion of quality based on odor, which was the method used, was as follows: odors associated with canned tuna are ordinarily expected to be quite bland and mild—with only a vegetable oil component predominant and no marked odors indicative of deteriorative changes in the fat or other constituents being noticeable. Cans with bland, mild odors usually have low V. R. S. contents. In Table 5, V. R. S. values are shown for individual cans of tuna of various species and pack styles. These cans were warehouse samples collected from packers in California for the Second Annual Tuna Cutting held December 1952 in Long Beach. The 3 styles of pack in the various species represent individual packers. An examination of this table reveals certain information. There is a distinct difference in V. R. S. values between the 3 types of packs, with those for the grated tuna usually highest, and those for the solid tuna lowest. This difference is most marked for the albacore tuna, but nevertheless still noticeable in other species. However, there is no uniformity, since cans from some packers show greater differences between styles than those from others. These variations in the V. R. S. content correlated to a certain extent with the organoleptic findings. The grated samples (and to a lesser extent, the pieces) of tuna with the highest V. R. S. values in general had the strongest odors, which were mostly indicative of fat oxidative changes. However, the correlation was not very close since some cans with no marked odors had a relatively high V. R. S. content. These observations might be interpreted that the increases from solid through pieces to grated packs often encountered is not a necessary occurrence but likely reflects operating procedures. In Table 6 are shown average V. R. S. values for 3 species and a number of individual packers and separate plants of one packer, indicated by the letters after the numbers. The generally higher average V. R. S. values for skipjack tuna is notworthy, with a few V. R. S. values for skipjack in the range of values found for the other species. This again may be interpreted as indicating that the high V. R. S. values are not characteristic for the species but may represent treatment and handling of the material during catching and processing. The data further indicate that complete uniformity of operation is apparently not present in different plants of one packer. The V. R. S. values for the cans of plants 6A, 6B and 6C illustrate this point. The data of Tables 5 and 6 are to be regarded as orientative, since only one can of each species and style from a single packer was used. These data are intended to point out that the determination of the V. R. S. content offers a useful tool in an approach to the establishment of a quality rating for packs of fish, within the meaning of the word in this section. The organoleptic means is not sufficiently amenable to quantitation to serve adequately and solely this purpose. It may be used in conjunction with the chemical method in setting up grades or quality ratings.

TABLE 5

Volatile reducing substances in canned tuna of various species

Species	Volatile reducing substances in		
	Solid	Pieces	Grated[b]
Albacore	8.7	10.7	14.6
	10.3	12.8	16.5
	7.5	15.0	19.9
	7.6	16.3	14.8
	15.4	15.8	—
	8.9	—	18.8
	8.4	—	14.5
Yellowfin	8.8	9.7	11.4
	12.1	12.4	11.7
	15.4	15.3	14.8
	12.2	—	16.7
Skipjack	—	12.5	16.1
	—	8.4	19.7
	—	17.3	16.9
Bluefin	8.4	10.5	14.5
	14.7	—	15.1

[b] In general the grated samples (and pieces to a lesser extent) with the highest V. R. S. values had the strongest odors, mostly suggesting fat oxidative changes. However, this correlation was not consistent, since some cans with no marked odors had high V. R. S. values.

TABLE 6

Volatile reducing substances in various species of canned tuna

Cannery number	Average V. R. S. in		
	Albacore	Yellowfin	Skipjack
1	7.5	13.5	17.2
2	11.3	6.5	19.3
3	14.7	15.2	17.4
4	11.9	10.0	16.5
5A	12.7	11.8	19.6
5B	12.5	15.0	—
6A	11.3	10.9	19.2
6B	13.2	11.3	14.1
6C	9.5	12.1	16.8

SUMMARY

Experimentally obtained data for volatile reducing and nitrogen compounds in commercial samples of raw and canned fish have been presented. The results show that the Volatile Reducing Substances method offers a means of accurately and practically assessing the quality of a fish product, both in the sense of its wholesomeness and fitness for use and of attempting to establish grades, classes, or ratings as an approach to some condition considered ideal or most desirable for the particular commodity. To accomplish the above purposes ranges

of V. R. S. values for each product will have to be determined, as well as the distribution of the V. R. S. values within each grade or class.

LITERATURE CITED

1. Conway, E. J. *Micro-Diffusion Analysis and Volumetric Error*, rev. ed., 1947. D. VanNostrand Co. Inc., New York.
2. Farber, L. Chemical evaluation of odor intensity. *Food Technol.*, 3, 300 (1949).
3. Farber, L. A comparison of various methods for the determination of spoilage in fish. *Food Technol.*, 6, 319 (1952).
4. Lang, O. W., Farber, L., Beck, C., and Yerman, F. Determination of spoilage in protein foodstuffs with particular reference to fish. *Ind Eng. Chem., Anal. Ed.*, 16, 490 (1944).

Flavor Evaluation of Canned Cling Peaches[a]

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An attempt is being made to correlate one or more analyzable chemical or physical properties of cling peaches, such as the ratio of soluble solids to total acidity, volatile reducing substances or color with flavor of the canned fruit as evaluated by organoleptic methods. Such an objective analytical procedure, particularly one that is applicable to the raw fruit, would be of considerable value to the canning industry in improving the quality of canned cling peaches.

For the 1952 season Halford cling peaches grown in California have been sorted according to size and maturity and canned under rigidly controlled conditions by commercial procedures. Samples of each lot were analyzed for total acid, soluble solids, pH, ascorbic acid, tannin, volatile reducing substances, texture and color before canning. About 60 days after canning, the samples were submitted to panels for organoleptic evaluation. Portions of those same samples were analyzed for chemical and physical properties.

The results of these flavor ratings by taste-test panels have been compared with the chemical and physical analyses and useful correlations are indicated.

A major problem in canning cling peaches is the flavor evaluation of the canned product. Flavor in the canned fruits is dependent to a large extent on the maturity and handling of the fresh fruit prior to canning. Numerous investigations have been reported on maturity and canning quality of freestone peaches *(1, 5, 7, 8, 18, 21, 22)*, but information on harvesting maturity of cling peaches and their influence on quality of the canned product is meager.

Thorough investigations on the maturity of freestone peaches and its influence on the quality of the canned product have been published by Neubert *et al. (21, 22)*, and Caldwell and coworkers *(5, 7)*, but these studies give no information on canning of clingstone peaches. Although Allen *(1)* considered certain changes in cling peaches during ripening, he did not work with the canned product.

In view of these facts, an attempt is being made to correlate certain objectively determinable factors with flavor of the canned fruit as evaluated by organoleptic methods. Such an objective analytical procedure, if correlated with the more subjective organoleptic tests, would be of considerable value to the canning industry and to plant breeders in improving the quality of canned cling peaches.

[a] Presented before the Thirteenth Annual Meeting of the IFT, Boston, Massachusetts, June 24, 1953.

EXPERIMENTAL MATERIALS AND METHODS

Raw materials selection. The fruit used in these experiments was all from the Marysville District, which is one of the 4 principal peach producing areas in California. In the season of 1952, 12 tons of Halford cling peaches was harvested from commercial orchards in good condition and under normal cultural practice. The average age of the trees ranged from 5 to 10 years. Sufficient fruits of desired size and color were selected from each lot to yield at least one case (24 x No. 2½ cans) of canned product. A total of 55 cases of canned peaches of different maturities and sizes was obtained.

The color classification was made according to the procedure developed by Whipple *(27)*, in which flesh color of the peaches was compared to yellow-colored rings under a standard light source. The color of the optimum maturity ring is comparable to plate 9L 6 in Maerz and Paul's *(19) Dictionary of Color*, whereas the minimum maturity ring is closest to plate 10K 3. Peaches of minimum-maturity color will just make choice-grade canned peaches in accordance with U. S. D. A. standards. The color grading of the fresh peaches was done according to the following scheme:

Color descriptions used in harvest maturity study of cling peaches

Visual color	Approximate Maerz and Paul color plate	Approximate peach color number	Suitability for canning
Green	Plate 19, K5 to K6	1.0	Too green
Light green	Plate 19, K2 to K3	2.0	Too green
Light yellow	Plate 19, K1	3.0	Not matured for canning
Yellow, with light orange cast	Plate 9, K2	3.5	Below minimum maturity
Yellow, with moderate orange cast	Plate 10, K3	4.0	Minimum maturity
Yellowish orange	Plate 9, K4	4.5	Middle maturity
Yellowish orange	Plate 9, L6	5.0	Optimum

The peaches were classified into 6 size ranges according to their suture diameters, i.e. 2¼ to 2⅜ in.; 2⅜ to 2⁵⁄₁₆ in.; 2⁷⁄₁₆ to 2½ in; 2½ to 2¾ in.; 2¾ to 3 in.; and over 3 in. Size separation was based on the largest diameter perpendicular to the axis of the fruit that will not pass circular rings of a given diameter *(10)*. The peaches were picked in the morning and canned the following morning.

Physical and chemical tests. Ten representative peaches from each size and color classification of fresh fruit were used for the investigation of physical and chemical properties. Analyses of the fresh samples were made within 24 hours after the time of harvest.

Total titratable acidity. Duplicate 10 g. samples of the pulped peaches were obtained by disintegrating pitted and halved fruits

in a Waring blender. Then 200 ml. of distilled water was added and the resulting mixture titrated with standard 0.1 N. sodium hydroxide to pH 8.0 using a glass electrode. The results were expressed as percent citric acid monohydrate.

Soluble solids. The soluble solids content of the pulped peaches was determined by refractometer. Readings so obtained were corrected to 20° C.

Ascorbic acid. Ascorbic acid content was determined by the 2,6-dichlorophenolindophenol titration method *(2)*.

Tannin. Tannin content was determined with the Folin-Denis reagent as described by Guadagni *(13)* and Pro *(24)* with certain modifications. The polyphenolases were inactivated by blending 100 g. of the diced peaches with 50 ml. of 95% ethyl alcohol and 50 ml. of 6% meta-phosphoric acid in a Waring blender for 20 seconds. Then 20 g. of the slurry was diluted with 70% ethyl alcohol to 100 ml. in a volumetric flask. The sample was filtered through Whatman No. 1 filter paper. Three ml. of the filtrate was pipetted into a 100 ml. volumetric flask containing 50 ml. of water and 5 ml. of Folin-Denis reagent. Twenty ml. of 1 N. sodium carbonate was pipetted into the resulting mixture with vigorous agitation. The contents were diluted to 100 ml. with distilled water and mixed. The blue color that developed after 1½ hours was measured in the Klett-Summerson Photocolorimeter, using a No. 66 red filter. Sometimes it was necessary to centrifuge for 5 minutes to remove the precipitated calcium carbonate. A blank was run on a mixture of the reagents. A standard absorption curve for C. P. tannic acid was constructed with concentrations ranging from 0.05 to 1.0 mg. of tannic acid per 100 ml. Since it was observed that ascorbic acid also gives a blue color with the Folin-Denis reagent, it beca ie necessary to correct the results of the tannin determination when ascorbic acid was present. (Calibration curves made using mixtures of known amounts of tannic and ascorbic acids indicated that the color developed by 1.00 mg. of tannic acid was equivalent to that developed by 1.25 mg. of ascorbic acid.)

Volatile reducing substances. The amount of volatile reducing substances in canned peaches was determined by steam distilling a mixture of 50 g. of the pulped sample in 50 ml. of water. The distillate was collected directly in 10 ml. of 0.1 N. potassium permanganate in 1 N. sodium hydroxide. Any uncondensed volatile compounds were sucked through a sintered glass tube into a receiver tube containing 10 ml. of the same potassium permanganate reagent. Distillation was discontinued after 170 ml. of the distillate had been collected in about 30 minutes. The distillation was done under a slight negative pressure created by a water aspirator. The contents of the receivers were transferred into glass-stoppered Erlenmeyer flasks and kept in the dark for 30 minutes. Then 10 ml. of 5 N. sulfuric acid and 10 ml. of 30% potassium iodide were added to the flask. The iodine liberated was titrated with 0.1 N. sodium thiosulfate, using soluble starch as the indicator. Results were reported as micro-equivalents of potassium permanganate per 50 g. of sample. A blank was run using 50 ml. of water instead of the sample.

Texture. Pressure tests on the fresh peaches were made with 2 Ballauf fruit pressure testers equipped with plunger 5/16 in. in diameter, and giving pressure readings ranging from 0-30 pounds and 0-10 pounds, respectively. Ten readings were made on each batch of sample on the cheek side of the peaches.

Christel Texture Meter readings were made with 57 g. of diced peaches in the texture meter cup. Five readings were made on each sample.

Canning. Peaches of desired size and color classifications were halved and pitted in an F. & P. peach pitter (Fruit Machinery Co.). The halved peaches were lye-peeled by immersion in boiling 1% sodium hydroxide for one minute, and then were washed thoroughly in cold water. After sorting for defects and re-sorting for color, 19.5 oz. of peaches was weighed accurately into each No. 2½ can. Then 9.5 oz. of 40° Brix sucrose syrup was added. The cans were sealed under 15 in. of vacuum, and cooked in a boiling water bath for 30 minutes. The canned peaches were then cooled rapidly in running water and stored at room temperature for a minimum of 2 months before objective or subjective testing.

Organoleptic flavor evaluation. *Triangular tests.* Samples of canned Halford peaches covering the range of maturities and sizes were selected for testing. A panel of 14 randomly-selected judges compared the samples in pairs using the *triangular* test. In this design judges are presented with 3 samples, identical in appearance, but with one differing from the other 2 in some respect. The judges were asked to identify the identical samples, and to indicate their preference on the basis of flavor alone. In preparing samples for serving, the drained peaches from three No. 2½ cans were put through a food chopper to minimize differences due to size and texture, and then recombined with 200 ml. of the syrup. Where color differences existed between samples, they were eliminated by the use of a small amount of certified yellow food color (F. D. & C. Yellow No. 6), or by an amber filter on the lights in the tasting booths or both. Each pair of samples was compared by the panel once per day for three consecutive days, so that a total of about forty individual judgments was obtained for each pair compared. The number of correct separations, and the preferences of those able to make correct separations were analyzed statistically for significance level.

Balanced incomplete block design. Nine samples of canned Halfords of different sizes and maturities were evaluated for flavor using a balanced incomplete block design. Twelve judges were selected for the panel on the basis of their ability to identify correctly the identical samples in triangular tests and to reproduce their scores on standard samples on successive days. The 9 samples were served 4 at a time on 18 different days, in such a manner that each sample was served exactly 8 times, and each sample was served along with each other sample exactly 3 times. At each session the judges were asked to arrange the 4 peach samples in the order of their preference, and also to score them for flavor on a scale of 1 to 10. Samples were scored as follows: *excellent*, 9 to 10 points; *good*, 7 to 8; *fair*, 5 to 6; *poor*, 3 to 4; and *very poor*, 1 to 2. The samples were prepared in the same way as for the triangular taste tests. A portion of each prepared sample was analyzed chemically by the methods previously described. Data obtained from this experiment were analyzed statistically by a method devised by Tukey *(25)*.

RESULTS AND DISCUSSION

Characteristics of Halford cling peaches at harvest. The flavor of canned cling peaches is dependent first on the maturity and handling of the fresh fruit prior to canning, and second on the proper application of canning technology. Owing to lack of information on objective methods for determining harvest maturity of cling peaches, canners have based the ripeness of their fresh fruit solely on the subjective judgment of experienced personnel. Seeking practical and objective methods for determining harvest maturity, the physical and chemical properties of Halford cling peaches at various harvest maturities were investigated both before and during the normal harvesting period. The results are presented in Tables 1 and 2.

Data in Table 1 indicate the gradual change in color of the peaches from green to yellow during maturation on the tree. The yellow color of the flesh develops in advance of the skin color. Similar results have been reported by Neubert and coworkers *(22)* for Elberta peaches. Due to the possible fluctuation of color in peaches from year to year and from orchard to orchard, the exclusive use of color standards for harvesting cling peaches is still subject to limitations. Nevertheless, among all the possible methods for maturity evaluation, color is one of the most practical indices. Kramer *(15, 16)* has reported that as freestone peaches mature their green pigment content decreases, and this can be determined by spectrophotometric or fluorometric methods.

Texture. Pressure testing is one of the methods used to evaluate maturity of freestone peaches, pears, apples

TABLE 1

Effect of harvest maturity on physical properties of Halford cling peaches,[b] 1952

Date of harvest	Average diameter of peaches in cms.			Skin color	Flesh color	Pressure in p.s.i.	Christel texture meter reading	Maturity
	Suture	Cheek	Longitudinal					
7/28	6.78±0.24	7.08±0.15	6.60±0.60	2.0	3.0	18.1 ±1.5	155.0± 7.0	green
8/6	7.05±0.22	7.30±0.33	6.59±0.27	2.0	3.0	13.7 ±0.97	120.4±13.4	green
8/12	6.98±0.13	7.19±0.29	6.46±0.22	3.0	3.5	10.25±0.85	98.0± 3.3	not matured
8/20	7.25±0.29	7.53±0.27	6.59±0.26	3.75	4.0	10.40±2.40	86.0± 3.7	not matured
8/21	7.03±0.16	7.60±0.28	6.45±0.45	3.75	4.0	7.63±0.41	73.0± 4.2	minimum maturity
8/22	7.12±0.29	7.16±0.21	6.36±0.21	4.75	4.5	8.60±1.49	82.0± 7.5	middle maturity
8/22	7.21±0.16	7.16±0.20	6.45±0.28	5.0	5.0	7.20±1.12	70.6± 4.3	optimum maturity

[b] Peach sizes varied from 2¼ to 3" in largest diameter.

and other fruits *(1, 21, 22)*, although Neubert *(22)* has mentioned that pressure tests are of limited usefulness. Our results indicate that when Halfords reach 7.2 pounds pressure test they have attained optimum color grade. Similar trends were obtained by using the Christel Texture Meter on the same samples. Since peaches of different varieties and localities may not register the same pressure test even at the same stage of maturity, this work may not be generally applicable. Furthermore, the difference in pressure readings and texture meter readings between minimum and optimum color ranges was not sufficiently large. Thus texture readings can serve only as a rough estimate of maturity of cling peaches.

Total acid. The total acid content of Halford cling peaches decreases as they become more mature on the tree (Table 2). That there is a gradual decrease in acidity with maturation has similarly been reported by Allen *(1)* and Neubert *et al. (22)*. As will be shown later, the acid content of the fresh peaches prior to canning is related to the flavor of the canned product.

pH. The pH values show trends similar to total acidity. As the fruits develop on the tree, the pH increases. Owing to the highly buffered system in the peach, the pH is not sensitive enough for maturity evaluation in the canning range.

Soluble solids. At various harvesting maturities covered by this study, gradual increase of soluble solids with maturation was observed. In comparison with the color and texture readings, it seems that soluble solids content alone is not a critical index of maturity. Fisher *(11)* also has stated that the difference in soluble solids between mature and immature freestone peaches is too small to be of value as a maturity index.

Ratio of soluble solids to total acids. The above data have indicated an increase in soluble solids and a decrease in total acids during maturation of peaches on the tree. In green fruit the soluble solids content is lower, but the acid content is higher than in matured fruit. By taking the ratio of the soluble solids to total acid (S. S./A), a number is obtained which is even more indicative of the maturity changes. Table 2 indicates that the value of S. S./A increases gradually from 16 to 36 during maturation of Halford peaches on the tree.

Ascorbic acid. The ascorbic acid content of Halford peaches increases with maturation on the tree. In very green peaches only 4 to 5 mg. of ascorbic acid per 100 g. of peach tissue was found. In the case of matured peaches, 14.4 mg. per 100 g. was observed. This result seems to be contradictory to the work of Zielinski *(28)* who stated that at the time of harvest there was no significant difference in ascorbic acid content. He demonstrated, however, that significant differences in ascorbic acid content may be found among different varieties of Oregon freestone peaches. Lantz *(17)* reported that the variation in ascorbic acid content in New Mexico freestone peaches was from 4 to 33 mg. per 100 g. of peach tissue. At any rate since ascorbic acid content in fruits seems to vary among varieties, it probably will not serve as an effective criterion of maturity when considering a number of different varieties.

Tannin. The amount of oxidizable tannin in Halford peaches remains practically unchanged during the first stage of maturation on the tree. During later stages of maturation it increases slightly. Since tannin content in freestone peaches has been reported to be a characteristic of variety *(3)*, and also to vary from year to year *(22)*, it probably will not serve as a criterion of maturity of the fresh peaches. Although Neubert *et al. (22)* found a slight decrease in tannin content during maturation, their data were not entirely consistent.

Flavor evaluation by triangular taste test. After a storage period of 2 to 3 months at room temperature, the canned peaches were evaluated for flavor by triangular taste tests. The color and size classifications previously described formed the pattern of tests. The results are presented in Table 3.

In comparing peaches of optimum color, but of dif-

TABLE 2

Effect of harvest maturity on chemical properties of Halford cling peaches,[c] 1952

Date of harvest	Days before normal harvest period [d]	pH	Total acid as % citric monohydrate	Soluble solids in ° Brix at 20° C.	Ratio of soluble solids to acids	Ascorbic acid in mg./100 g.	Tannin mg./100 g. corrected for error due to ascorbic acid
7/28	22	3.70	0.809	13.40	16.56	5.56	
8/6	14	3.68	0.728	12.34	16.28	4.79	164.5
8/12	8	3.68	0.708	11.80	16.67	5.17	157.2
8/20	0	3.90	0.599	12.08	20.20		
8/21	0	3.90	0.589	13.44	22.80	9.23	165.2
8/22	0	3.88	0.540	14.41	26.70		
8/22	0	4.05	0.415	15.08	36.30	14.40	209.7

[c] Peach sizes vary from 2¼ to 3" in largest diameter.
[d] Normal harvest 8/20 to 8/28.

ferent sizes, it was interesting to observe that among fresh peaches of similar color classification those of larger size and lower S. S./A yielded a canned product of higher acceptance than those of smaller size and higher ratio. This was evidenced by comparison of sample A1 *vs.* A3, and also B2 *vs.* B4. Sample A1 which was canned from fresh fruit with a S. S./A of 26.7, was preferred over sample A3, which had a ratio of 35.2 in the fresh fruit. In accord with this, samples C3 and C5,6 which had similar acid contents and S. S./A for the raw fruit, were not differentiated by the panel.

When comparing the flavor score of canned peaches which were obtained from minimum-color maturity ranges (Table 3, row B), it can be seen that fresh peaches of higher S. S./A were almost always preferred to those with lower ratios. Thus the preference for higher S. S./A in the minimum maturity classification is the reverse of that in the optimum range. When the fresh fruits have similar S. S./A, the panels expressed no statistically significant preference for either sample.

When canned peaches derived from fresh peaches of optimum-color maturity were compared with those canned from minimum-color (Table 3, row C), the number of judges making correct separations was much higher. The preference for peaches at optimum maturity over minimum maturity was highly significant.

Based on the above results, it is reasonable to suggest that Halford cling peaches be harvested at optimum color, and also at S. S./A above 25.0 but preferably below 32.0 since very high ratios tend to be associated with over-mature fruit.

Flavor evaluation by block design method. In another approach to flavor evaluation, 9 samples of canned Halfords of different maturities and sizes were taste tested according to a block design method. The judges were asked to score four samples at a time in different combinations, each sample being evaluated eight times in all. The results are presented in Table 4.

These data indicate that the 9 samples may be divided into 3 ranks for flavor. The samples 1, 2, 3, 4, and 5 have approximately equal total scores, ranging between 347 and 374. The differences between samples in this range are not statistically significant. The flavor of these 5 samples was superior to the flavor of the remaining samples.

Sample 6 is of medium quality and its total score of 306 is significantly lower than that of any of the first five.

The samples 7, 8, and 9 scored significantly lower than either of the first 2 groups. There were no statistically significant differences between scores in this last group.

In comparing the fresh fruit of the samples one through 5, all had S. S./A above 25, i.e., 26.7 to 36.3 and flavor-wise they scored higher than peaches of minimum maturities.

The fact that in some cases peaches with different S. S./A were judged significantly different in flavor by the triangular test, and yet received similar scores in the block design, is not difficult to explain. It is possible for 2 samples to be quite easily discernible from one another, by virtue of differing S. S./A or for other reasons, and indeed to have rather different tastes, yet these tastes may be about equally acceptable to the panel. The triangular design is much more sensitive to small differences, but not as applicable to the measurement of preferences as the block design. The latter in this in-

TABLE 3

Results of triangular taste tests on canned Halford cling peaches of different maturities and sizes

Sample	Color class.	Size	Fresh Fruit: Soluble solids %	Fresh Fruit: Total acid [g] %	Fresh Fruit: Soluble solids to total acid ratio	Acceptance Data: No. of judges	Acceptance Data: No. of correct separations	Acceptance Data: Preference [e]	Probability level of preference [f]
(A) Comparison of sizes and soluble solids total acid ratio in optimum maturity.									
A 1	optimum	3"	12.51	.470	26.7	37	25	76%	1%
A 3	optimum	2 1/2-2 3/4"	13.75	.393	35.2			24%	
C 3	optimum	2 1/2-2 3/4"	13.75	.393	35.1	39	18	50%	>5%
C 5, 6	optimum	2 1/4-2 7/16"	13.95	.386	33.5			50%	
B 2	optimum	2 3/4-3"	13.50	.462	29.5	41	19	79%	1%
B 4	optimum	2 7/16-2 1/2"	13.84	.395	34.5			21%	
(B) Comparison of sizes and soluble solids total acid ratio in minimum maturity.									
D 7	minimum	3"	13.5	.593	22.1	42	21	76.2%	2%
D 9	minimum	2 3/4-3"	10.07	.553	18.5			23.8%	
E 8	minimum	2 3/4-3"	11.96	.606	19.80	34	23	60.8%	>5%
E 10	minimum	2 7/16-2 1/2"	10.71	.564	18.80			39.2%	
I 9	minimum	2 1/2-2 3/4"	9.11	.624	14.60	34	15	30.6%	>5%
I 11	minimum	2 3/8-2 7/16"	8.71	.619	14.07			69.4%	
H 8	minimum	2 3/4-3"	10.51	.630	16.68	36	14	91.6%	1%
H 10	minimum	2 7/16-2 1/2"	9.21	.628	14.67			8.4%	
(C) Comparison of sizes and soluble solids total acid ratio in minimum and optimum maturity.									
F 2	optimum	2 3/4-3"	15.08	.415	36.30	38	35	82.2%	<0.1%
F 8	minimum	2 3/4-3"	10.50	.630	16.68			17.8%	
G 3	optimum	2 1/2-2 3/4"	13.94	.438	31.80	33	31	90.2%	<0.1%
G 9	minimum	2 1/2-2 3/4"	9.11	.624	14.60			9.8%	

[e] Percentage of those able to separate identical samples correctly, preferring indicated samples.
[f] A probability level of greater than 5% is not considered statistically significant.
[g] As percent citric acid monohydrate.

TABLE 4

Block design taste test and chemical analysis on canned Halford cling peaches of different maturities and sizes

Sample no.	Size of peach	Color	Fresh fruit: Soluble solids %	Fresh fruit: Total acid [1] %	Fresh fruit: Soluble solids to total acid ratio	Canned fruits: Soluble solids %	Canned fruits: Total acid [1] %	Canned fruits: Soluble solids to total acid ratio	Canned fruits: pH	Canned fruits: Tannin mg./100 g.	Canned fruits: Ascorbic acid mg./100 g.	Canned fruits: Volatile reducing substances [2]	Average acceptance score	Total acceptance score [3]
1	3"	optimum	13.18	.465	28.3	21.5 ±0.20	.367±.014	58.6±1.8	3.90±.04	104.5±14.0	2.18±.32	161.1±31.6	7.01±.52	347
2	2 3/4 3"	optimum	15.08	.415	36.3	21.55±0.57	.332±.014	64.6±3.1	3.95±.07	118.5± 5.7	1.95±.51	177.5±14.0	7.24±.32	365
3	2 1/2 2 3/4"	optimum	13.28	.382	34.7	20.22±0.16	.301±.028	67.7±5.8	4.07±.03	113.4± 9.2	1.62±.19	180.2±20.1	6.83±.58	364
4	3"	middle	14.31	.534	26.8	21.08±0.53	.361±.011	58.5±2.5	3.91±.04	92.6±12.6	1.34±.38	196.8±21.1	7.36±.65	361
5	2 3/4 3"	middle	14.41	.540	26.7	21.28±0.32	.374±.014	57.0±2.0	3.89±.04	98.5±10.7	1.94±.49	177.8±16.7	7.52±.35	374
6	2 1/2 2 3/4"	middle	10.23	.452	22.7	19.06±0.40	.303±.007	62.9±1.5	4.07±.06	90.9± 8.0	0.77±.27	154.8±22.6	6.17±.61	306
7	3"	minimum	13.54	.604	22.4	19.92±0.33	.396±.019	50.4±2.3	3.85±.04	84.5±18.0	0.90±.22	145.5±19.6	5.26±.48	227
8	2 3/4 3"	minimum	13.44	.589	22.8	19.80±0.11	.364±.010	53.5±1.3	3.88±.04	79.5±10.8	0.62±.24	131.3±18.8	5.36±.65	241
9	2 1/2 2 3/4"	minimum	10.94	.544	20.2	19.23±0.20	.251±.014	54.8±1.8	3.92±.07	79.8±13.3	0.37±.12	152.7±31.2	5.04±.63	220

[1] Difference necessary for 5% level of significance between acceptance scores: 40.5.
Difference necessary for 1% level of significance between acceptance scores: 56.7.
[2] As percent citric acid monohydrate.
[3] Micro equivalents of potassium permanganate per 50 g. sample.

stance does not even separate some of the samples in the middle maturity classification from those in the optimum. The positions of samples 4 and 5 does, however, aid in establishing the suggested division point of S. S./A between optimum and minimum as discussed in the section on predicting the flavor preference of cling peaches.

The tannin content is higher in the canned peaches of optimum than in those of middle or minimum maturities. Neubert and coworkers *(22)*, however, reported a decrease in tannin with maturation in freestone peaches, although they did not correct for the error due to ascorbic acid. It remains to be seen by further investigation whether the increase in tannin content with maturity is characteristic of all varieties of cling peaches.

The ascorbic acid content of the canned samples was higher in the optimum maturity peaches than in the middle and minimum. This relationship also existed in the fresh fruit. Since optimum maturity is correlated with optimum flavor, it might be said that canned peaches of higher ascorbic acid content are more desirable from a flavor standpoint. Whether this is a causal relationship or merely coincidental also needs further confirmation.

The volatile reducing substances in canned Halfords also increased with the maturity of the fruit. In the optimum maturity fruit a range of 160 to 180 micro-equivalents per 50 g. was found, whereas in the minimum-maturity fruit only 130 to 150 micro-equivalents per 50 g. sample were found. The total acceptance scores are very well related to the volatile reducing substances in the canned product. Confirmation of this on a wide variety of samples would provide an extremely useful relationship.

Prediction of flavor preference of cling peaches. We have shown that the correlation of the flavor of cling peaches with their color, texture, ascorbic acid content, soluble solids, or total acidity is possible, but any one factor used alone is not sufficiently precise or unambiguous to establish a standard for flavor evaluation. These properties or analyses may only be used as auxiliary methods of flavor evaluation. However, the use of the ratio of S. S./A in the fresh fruit as a criterion for predicting flavor preference is particularly promising. Since the soluble solids content increases with maturity, and the acidity decreases with maturity the ratio of the 2 factors cannot be clearly defined unless one of them is held as a reference factor. Due to the fact that the acidity of the fruit plays a more important role than the soluble solids in influencing flavor, it is reasonable to define the ratio of soluble solids to total acid with reference to the level of acidity. Figure 1 is obtained by

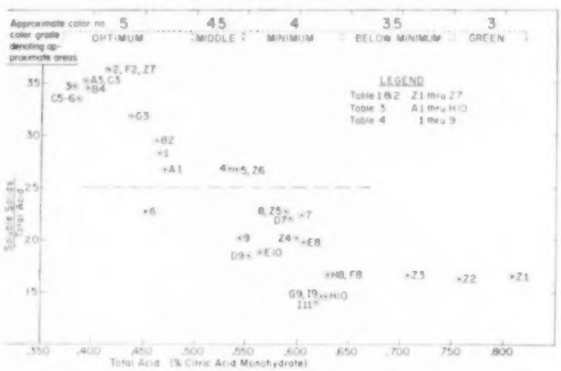

Figure 1. Maturity trends of Halford cling peaches.

plotting the S. S./A against total acidity, using all the samples of Halfords shown in Tables 2, 3, and 4. It shows a gradual increase in the ratio with decrease in total acidity. Samples with ratios above 25 and with an acid content below .50% were in the optimum color classification.

Peaches whose ratio falls below 25 may be classified as minimum maturity when their total acidity ranges from .54 to .64% as citric acid monohydrate. Samples 4, 5, and 6 fall somewhat outside these areas, but all are close to the suggested dividing line of 25 on the S. S./A scale shown in Figure 1.

The classification of flavor preference of peaches according to their S. S./A as related to total acidity may not be considered as an absolute scale. The variables of variety, season, and cultural practice may shift these ranges. The results presented here serve

only as an approach to an understanding of the problem of flavor evaluation of canned cling peaches. Confirmation of these relationships with samples of the major varieties and from the principal districts will make this information more useful in solving practical problems.

SUMMARY

The physical and chemical characteristics of Halford cling peaches harvested at different stages of maturity have been investigated with a view to correlation of one or more of these properties with flavor. Samples of Halfords canned at different stages of maturity and of different sizes were evaluated for flavor by triangular taste test and balanced incomplete block design. The results of this year's work indicated that optimum maturity for harvesting may be defined by using the ratio of the soluble solids to total acids (S. S./A) with reference to total acidity. If the ratio is above 25 and the total acidity is below 0.50% as citric acid monohydrate in the raw fruit, canned fruit of high flavor score is obtained. If the ratio is below 25 and the acidity ranges between 0.54 to 0.64%, canned peaches of poor flavor are obtained.

In addition to the S. S./A as a criterion for maturity, the factors of color, texture, and ascorbic acid may also be used as auxiliary indices, although they are not very critical. The comparison of flesh color of fresh cling peaches with standard color rings developed by Whipple *(27)*, as a criterion of maturity, has been investigated. It has been found to be useful in separating peaches of higher flavor preference from those of lower flavor preference.

In the optimum maturity range, the triangular taste panel shows a higher preference for the flavor of peaches which were canned from fruit of lower S. S./A ratio. In the minimum maturity range the preference is for those canned from peaches of higher S. S./A ratio.

Correlations have been observed between acceptance and certain chemical analyses of the canned peaches. It was found that canned peaches of higher volatile reducing substances, ascorbic acid, and oxidizable tannin contents gave higher flavor scores than those with lower contents of those materials.

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LITERATURE CITED

1. Allen, F. W. Physical and chemical changes in the ripening of the deciduous fruits. *Hilgardia*, **6** (13): 381-441 (1932).
2. Association of Vitamin Chemists, Inc. 1947. *Methods of Vitamin Assay*. Interscience Publishers Ltd., N. Y.
3. Blake, M. A., and Davidson, O. W. Some results of acidity and catechol tannin studies of peach fruits. *Proc. Amer. Soc. Hort. Sci.*, **39**, 201-204 (1941).
4. Blake, M. A. Additional studies of the acidity and tannin content of mature peach fruits. *Proc. Amer. Soc. Hort. Sci.*, **40**, 153-6 (1942).
5. Caldwell, J. S., and Culpepper, C. W. Further studies in utilization of eastern freestone peaches. I. Studies of canning quality. *Fruits Products J., and Am. Food Manuf.*, **23** (6): 170-173; 186-7; 191 (1944).
6. Crocker, E. C. Basic principles of flavor retention in foods. *Proc. Inst. Food Technologists*, 80-86 (1944).
7. Culpepper, C. W., Moon, H. H., and Caldwell, J. S. The comparative canning quality of some varieties of peaches grown in the East. *Canner*, July 17 and 24 (1937).
8. Culpepper, C. W., and Caldwell, J. S. Studies in preservation of eastern freestone peaches. *Proc. Amer. Soc. Hort. Sci.*, **46**, 241-5 (1945).
9. Davis, L. D. Relation between diameter and fresh weight of developing peach fruits. *Proc. Amer. Soc. Hort. Sci.*, **40**, 146-52 (1942).
10. Davis, L. D., and Davis, M. M. Size in canning peaches; the relation between the diameter of cling peaches early in the season and at harvest. *Proc. Amer. Soc. Hort. Sci.*, **51**, 225-30 (1948).
11. Fisher, D. V., Britton, J. E., and O'Rielly, H. J. Peach harvesting and storage investigations. *Sci. Ag.*, **24**, 1-16 (1943).
12. Gilpin, G. L., Ebner, K. R., and Geissenhainer, E. L. Sweetening agents for canned peaches. *Food Technol.*, **6**, 81-82 (1952).
13. Guadagni, D. G., Sorber, D. G., and Wilbur, J. S. Enzymatic oxidation of phenolic compounds in frozen peaches. *Food Technol.*, **3**, 359-364 (1949).
14. Guadagni, D. G., and Nimmo, C. C. Effect of growing area on tannin and its relation to astringency in frozen Elberta peaches. *Food Technol.*, **7**, 59-61 (1953).
15. Kramer, A., and Smith, H. R. Electrophotometric methods for measuring ripeness and color of canned peaches and apricots. *Food Technol.*, **1**, 527-539 (1947).
16. Kramer, A., and Haut, I. C. Ripeness and color studies with raw and canned peaches. *Proc. Am. Soc. Hort. Sci.*, **51**, 219-224 (1948).
17. Lantz, E. M. Ascorbic acid in peaches from New Mexico. *Food Research*, **16**, 77-9 (1951).
18. Lott, R. V. Relation between maturity and quality in the peach. III. *State Hort. Soc. Trans.*, **77**, 183-8 (1943).
19. Maerz, A., and Paul, M. R. *A Dictionary of Color*. 1930. McGraw-Hill Book Co., Inc., New York, N. Y.
20. McGlumphy, J. H. Fruit Flavors. *Food Technol.*, **5**, 353-355 (1951).
21. Neubert, A. M., Veldhuis, M. K., and Clore, W. J. Effect of harvest maturity on the canning quality of Western grown Elberta peaches. *Fruit Products J.*, **23**, 292-7, 315, 317 (1944).
22. Neubert, A. M., Schultz, J. H., Bedford, C. L., and Carter, G. H. Processing Wash. grown freestone peaches. State College of Wash., Agr. Expt. Sta. *Circ. No. 63* (1948).
23. Nightingale, R. M., Addoms, R. M., and Blake, M. A. Development and ripening of peaches as correlated with physical characteristics, chemical composition, and histological structure of the fruit flesh. III. Macrochemistry. New Jersey Agr. Expt. Sta. *Bull.* 494 (1930).
24. Pro, M. J. Report on spectrophotometric determination of tannin in wines and whiskies. *J. Assoc. Official Agr. Chem.*, **35**, No. 2, 255-257 (1952).
25. Tukey, J. W. Quick and Dirty Methods in Statistics. Part II. Simple Analyses for Standard Designs. *Am. Soc. Quality Control Conference*, **5**, 189-197 (1951).
26. Van Blaricom, L. O. Effect of syrup density on the flavor rating of canned peaches. *Proc. Amer. Soc. Hort. Sci.*, **50**, 220-30 (1948).
27. Whipple, S. R. Color comparison test to measure maturity of canning cling peaches. State of Calif., Dept. of Agr., Bureau of Fruits and Vegetable Standardization. *Mimeograph*. (1951).
28. Zielinski, Q. Peach varieties in relation to genetic and environmental factors. *Proc. Amer. Soc. Hort. Sci.*, **52**, 143-8 (1948).

Influence of Gram-Negative Bacteria on the Sauerkraut Fermentation[a,b]

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A study of 6 laboratory fermentations of sauerkraut showed that Aerobacter cloacae predominated in 5 of them. Flavobacterium rhenanus was found in only one of them. Mixed cultures of the above two organisms with acid-forming bacteria showed that if the A. cloacae and F. rhenanus were present in excess they prevented the normal fermentation of sauerkraut. A mixed culture of A. cloacae and Leuconostoc mesenteroides, in which the amount of inoculum of A. cloacae was reduced, produced acid at a faster rate than a pure culture of L. mesenteroides alone. The introduction of A. cloacae into normal sauerkraut fermentation showed that this organism was capable of causing dark sauerkraut with a sharp radish-like flavor which upon exposure to light became dark.

In the manufacture of sauerkraut, it is necessary to allow the shredded cabbage to undergo a bacterial fermentation. When proper conditions are maintained, the fermentation proceeds spontaneously after salting and the product is soon ready for the market. In the preservation of most vegetables, emphasis is upon the destruction or suppression of microbial growth rather than its propagation. In this respect, the sauerkraut fermentation is different. The bacterial growth enhances its palatability as contrasted to the rotting and putrefactive changes that spoil most other vegetable products salted under the same conditions.

After the salting period there is a consistent increase of titratable acidity throughout the course of the sauerkraut fermentation. The organisms concerned with the production of acidity have previously been identified *(2)* as *Leuconostoc mesenteroides, Lactobacillus plantarum* and *Lactobacillus brevis*. The delicate flavor of sauerkraut has been shown to be due to the growth of *Leuconostoc mesenteroides;* however, this organism is unable to complete the fermentation. The lactobacilli, therefore, are of great significance since they complete the fermentation by producing the desired acidity.

The delicate flavor and aroma of sauerkraut may not necessarily parallel the formation of titratable acidity. At times this may become a problem since the final product may possess a biting sharp flavor or other undesirable flavors even when the acidity is normal. At other times the product may be darkened or even lack the desired acidity. These abnormal fermentations are thought to be due to undesirable bacteria; however, no particular organism has been identified in this connection.

The organisms which have been shown to appear prior to the acid formers have been classified as the gram-negative group. It has been assumed that these gram-negative bacteria belong to a heterogeneous group present on the exterior of the cabbage and that they are not important since they disappear shortly after the salting period.[e]

The present study is concerned with the enumeration and identification of these gram-negative organisms that normally appear at the beginning of the sauerkraut fermentation. It was desirable to determine whether these organisms were capable of growing during the normal fermentation and to note whether abnormal changes in the product may be ascribed to these organisms.

EXPERIMENTAL

The cabbage for these experiments was shredded by using hand operated cutting boards. The shreds were weighed and transferred to a mixing vessel where salt was added in the amount of *2* percent by weight. The cabbage was transferred to a crock or gallon jar where the sauerkraut fermentation took place at room temperature (*22-25°* C.). A wooden cover was inserted and then sufficient weight was added to bring the juice to the top. A sample tube was then introduced into the cabbage mixture through a hole in the wooden cover. This sample tube was provided with a glass tip that filtered the cabbage juice by means of numerous small holes. The sample tube is a part of a sampling technique which was devised in order to insure representative samples for bacteriological investigation. The technique consisted of removing a portion of the fermenting cabbage juice to a sterile container which had been flushed with nitrogen to avoid the introduction of oxygen from the air. In this manner a volume of 170 to 210 ml. was removed from the fermenting cabbage to a sterile sample container by means of vacuum which was controlled at valve B shown in Figure 1. After representative samples had been taken from the sample container, the remaining fermenting cabbage juice could be returned to the crock or gallon jar by nitrogen pressure controlled at valve C. The three-way-through valve A provided a method for flushing

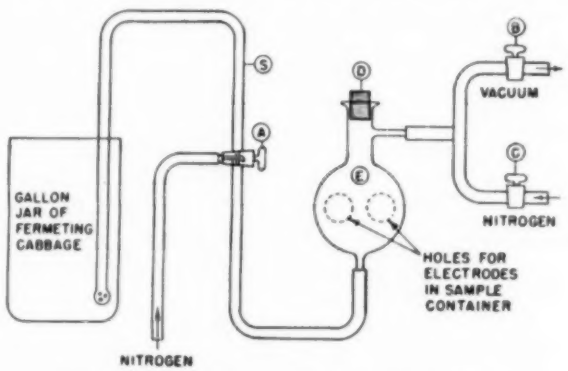

Figure 1. Schematic drawing of sampling device.

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[b] Presented at the Thirteenth Annual Meeting of the IFT, Boston, June 23, 1953.

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[e] An extensive literature review is reported in the original thesis; therefore, no lengthy account of past work will be given here. However, throughout the body of this publication occasional references will be made to the work of others when necessary.

the sample container with nitrogen gas before withdrawing the sample. This same valve also provided a method for agitating the sample when making electrode potential measurements.

Sterile salt-expressed cabbage juice was used for determining electrode potentials of gram-negative bacteria and acid-forming bacteria in pure culture. This same medium was used also in the study of the titratable acidity formed by these same organisms in mixed culture. The sterile salt-expressed cabbage juice was prepared by adding salt to the shredded cabbage in the amount of 2% by weight and setting the mixture aside for ½ to 2½ hours. At the end of this time the shreds were squeezed, the juice dispensed in the quantity desired for the particular test, and sterilized by autoclaving at 15 pounds for 15 minutes. The titratable acidity was determined during the sauerkraut fermentation by employing 0.01655 N NaOH using phenolphthalein as the indicator.

Tryptone glucose extract agar (Difco) was employed for total counts and V-8 medium (*1*) for enumeration of the acid-forming bacteria. In preliminary work it was found that the tryptone glucose extract agar with 0.04 g. brom cresol purple per liter was not suitable for determining the numbers of acid-forming bacteria during the initial stages of the sauerkraut fermentation. When the gram-negative isolates were streaked over the face of 24 hour cultures of acid-forming bacteria, it was found that within 4 to 6 hours the area below the gram-negative streak culture had changed from the yellow acid reaction to the initial purple reaction. Acid-forming bacteria could not be detected, therefore, when growing in close association with gram-negative organisms since the acid halo that characterizes the acid-forming bacteria would not be formed in plate culture.

RESULTS

In preliminary studies employing the V-8 medium a peculiar type of lenticular-shaped colony predominated before the acid-forming bacteria appeared. Figure *2* shows the relationship

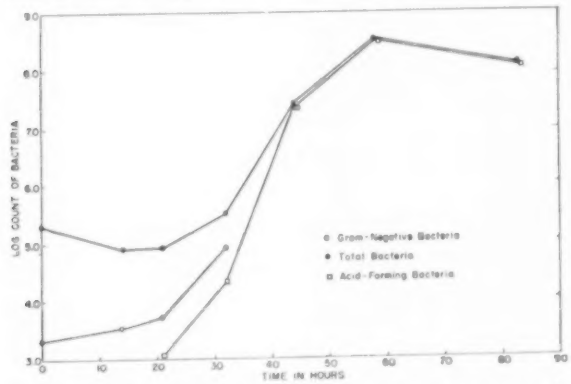

Figure 2. Bacterial growth during the beginning stages of the sauerkraut fermentation.

between the number of lenticular-shaped colonies, total count, and number of acid-forming colonies. These results represent a composite of three 10-gallon crock sauerkraut fermentations.

Six sauerkraut fermentations were carefully examined further to confirm the fact that lenticular-shaped colonies increase during the early stages. From this work it was found that these lenticular-shaped colonies predominated for periods ranging up to 35 or 45 hours. This range had been indicated also by the results of preliminary work, although in one case the period ranged up to 54 hours and in another case it was as low as 12 hours. In all cases their growth terminated shortly after the appearance of the acid-forming bacteria. In one fermentation it was not possible to follow the growth of the lenticular-shaped colonies because the acid-forming bacteria appeared so quickly.

Isolation of bacteria. The lenticular-shaped colonies were isolated during the study of the 6 sauerkraut fermentations in order to characterize these bacteria. The isolations were made from the second series of plates where a definite increase in the lenticular-shaped colonies was evident. Typical acid-forming bacteria were isolated also during the fermentation from the first plates that gave typical colonies of acid-forming bacteria.

Table 1 lists the various isolates that were obtained from the 6 fermentations. All the lenticular-shaped colonies were gram-negative, whereas, the acid-forming bacteria were gram-positive.

TABLE 1
Bacterial cultures isolated from six cabbage fermentations

Fermentation	Characteristics of colonies on V-8 medium	
	White lenticular	Acid-forming
	Isolate number	Isolate number
I	1-23	24-25
II	46-72, 82,83	73-81, 84, 85
III	100-106	107, 108
IV	200-201	202, 203
V	501-506	507a, 508a
VI	601-605	0
Gram character	Gram-negative	Gram-positive
Total number of isolations	73	38

Identification studies. A pure culture study was made of 14 representative gram-negative cultures chosen from the 6 fermentations listed in Table 1. The cell morphology of all the gram-negative bacteria studied in pure culture was determined from 12 to 48 hour cultures. In all cases the cell size varied from 1.0 to 1.3 microns in width and 1.3 to 1.5 microns in length. In most cases the cells were in pairs and appeared much like diplobacilli or even diplococci. A great number of cells that were found singly appeared almost spherical. Since these organisms appeared to be so similar to some acid formers, such as *Leuconostoc mesenteroides*, the gram stain was the only definite way of differentiating the acid formers from the gram-negative bacteria.

The biochemical tests used were those suggested by the *Manual of Methods for Pure Culture Study of Bacteria (5)*. The biochemical reactions showed that cultures 15, 18, 69, 102, 105, 106, 201, 601, 603, 604, and 605 conformed satisfactorily to the physiological characteristics of *Aerobacter cloacae*.

These results indicated that *A. cloacae* predominated in 5 of the 6 fermentations studied. In *2* of the fermentations there was an indication that other gram-negative organisms might be involved since organisms 18 and 200 had characters differing from those of 15 and 201 which were isolated at the same time and were shown to be *A. cloacae*. In the one fermentation where *A. cloacae* failed to appear, another gram-negative organism was isolated. The pure culture study of 501 and 506 showed that these organisms were *Flavobacterium rhenanus*.

Mixed culture study of gram-negative and acid-forming bacteria. The predominance of the gram-negative bacteria before the appearance of the acid-forming bacteria during the beginning stages of the sauerkraut fermentation suggested that the gram-negative bacteria might either effectively inhibit or stimulate the acid-forming organisms. Thus, the growth of the gram-negative bacteria would either hinder or favor the ultimate formation of acid throughout the fermentation.

In order to obtain evidence indicating the ultimate effect of the gram-negative bacteria, representative cultures were chosen from the gram-negative group and grown in mixed culture with members of the acid-forming group using salt-expressed cabbage juice as the culture medium. In addition to the mixed culture, the *2* groups of organisms were grown in pure culture. A comparison of the acid formation in pure and in mixed culture was made over a period of 7 to 14 days. The incubation temperature for the mixed culture study was *25°* to *27°* C.

The total acid formed per 10 ml. sample was determined by titration using 0.1655 N NaOH and phenolphthalein as the indicator. The contents of each tube were transferred to an Erlenmeyer flask and neutralized until a slight pink coloration was evident. In this way representatives of each series indicated the total acid formed as if removed from a single fermentation. When the quantity of acid produced in mixed culture deviated from the quantity in pure culture, the results were interpreted as evidence of factors which influenced the growth of the acid-forming bacteria. The amount of acid produced was used as a criterion in this manner since the gram-negative organisms only

slightly affected the titratable acidity as compared with the total effect of acid-forming bacteria.

The results of the entire mixed culture study (42 cross inoculations) showed the gram-negative to inhibit in 9 instances, to retard in 24 cases, or not to affect in 9 cases the formation of titratable acidity by the acid-forming bacteria. Figures 3a and 3d show representative examples of complete inhibition and of no inhibition in graphic form.

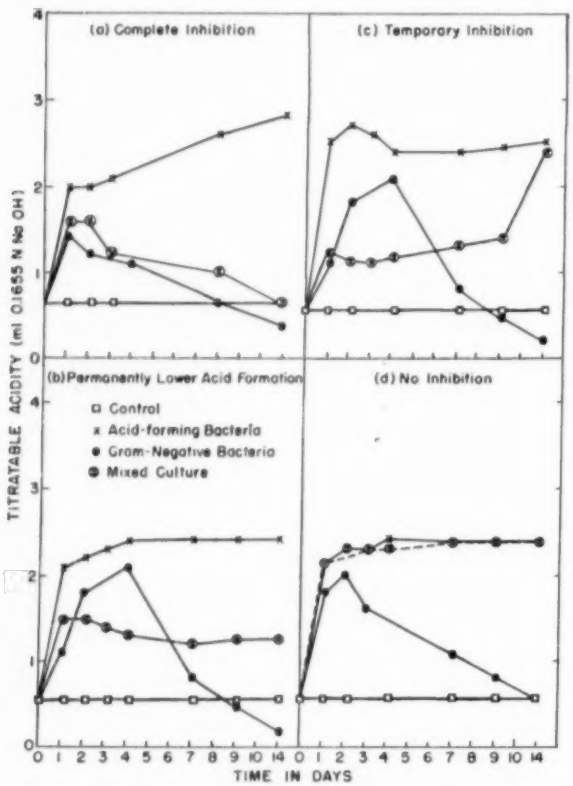

Figure 3. Influence of gram-negative bacteria on the amount of acid produced by lactic acid bacteria in sterile cabbage juice.

In the 9 cases where the acid formation was inhibited completely, *A. cloacae* was the cause of only 3 cases or 7% of the total mixed culture studies. However, in all 3 cases, the inhibited acid former was *L. mesenteroides*.

Of the 24 cases where acid formation was retarded by the gram-negative organisms, 63% of these resulted in lower amounts of acid formed during the incubation period. This indicated the undesirable nature of the gram-negative bacteria since their growth prevented the normal amount of acid from being formed. In the other 37% of the cases, the acidity arose slowly and approximated the value obtained by the acid bacteria in pure culture. Figures 3b and 3c are examples of each of these effects in graphic form.

In 5% of the total cross inoculation studies, *A. cloacae* had no effect on the formation of acid. In this case the formation of acid proceeded as if *A. cloacae* were not present.

The cause of the slow formation of acid or even complete inhibition in mixed culture remained as a point of conjecture. The large inoculum used in all this work was intentionally employed to show the effect of a large number of organisms as well as the products of their growth. Therefore, the inhibiting effects were possibly due to the by-products of the gram-negative bacteria as well as to the immediate effects of a large number of gram-negative bacteria.

Abnormal flavor and dark sauerkraut. The work on electrode potentials of normal and inoculated sauerkraut (to be published later) brought forth the possibility that *A. cloacae* might be the cause of the darkening of sauerkraut and abnormal flavor under certain conditions. As a result of the inoculation studies with *A. cloacae*, it is believed that the cause of the dark sauerkraut and abnormal flavors described by Pederson (*3, 4*), may have been due to gram-negative bacteria. Two days after the inoculation with the 50-ml. sample a slight brown coloration was noted throughout the shredded cabbage. As time progressed the darkening became more evident. These results were obtained in 4 studies where *A. cloacae* was introduced into the fermentation. In one experiment the wooden top was removed from the gallon jar 2 weeks after the start of the fermentation. In this case the browning increased at the surface and extended down into almost half of the contents. The normal fermentation showed no discoloration during the 2-week observation period. At the end of 2 weeks the cabbage to which *A. cloacae* had been added possessed a raw, sharp, nippy, radish-like flavor. The texture of this cabbage was examined, also, but no changes were noted. The normally fermented cabbage made at the same time and kept under the same conditions, but which was not inoculated with *A. cloacae* and which served as a control, had normal flavor and texture. As a result of these inoculation studies with *A. cloacae*, it is believed that this organism may be the cause of dark sauerkraut and abnormal flavors under certain conditions.

SUMMARY AND CONCLUSIONS

Under the conditions of these experiments the results may be summarized as follows:

Aerobacter cloacae and *Flavobacterium rhenanus* were identified as members of the gram-negative group found to be increasing in number during the beginning stages of the sauerkraut fermentation. The increase of these bacteria was determined by observing an increase in the number of lenticular-shaped colonies on a V-8 medium with a corresponding decrease of total count.

A. cloacae was isolated in five out of six fermentations studied and is considered of greater prevalence than *F. rhenanus* since the latter was isolated in only one of the 6 fermentations.

The study of *A. cloacae* and *F. rhenanus* in mixed culture with the acid-forming bacteria indicated that the presence of a large number of gram-negative bacteria, or their by-products, prevented the normal formation of acid by the acid-forming bacteria. When the amount of inoculum of *A. cloacae* was further decreased, acid was produced at a faster rate in the cabbage juice with the mixed culture of *A. cloacae* and *Leuconostoc mesenteroides* than when either organism was used separately.

The introduction of *A. cloacae* into the normal sauerkraut fermentation showed that this organism was capable of causing dark sauerkraut and at the end of 2 weeks produced a sharp radish-like flavor which was undesirable. The exposure of such sauerkraut to the air also intensified darkening.

LITERATURE CITED

1. Fabian, F. W., Fulde, R. C., and Merrick, J. A new V-8 medium for determining acid-producing bacteria. *Food Research*, **18**, 280-289 (1953).
2. Pedersen, C. S. Floral changes in the fermentation of sauerkraut. N. Y. Expt. Sta. *Tech. Bull.*, **168**, 1-37 (1930).
3. ———. Sauerkraut. N. Y. Agr. Expt. Sta. *Bull.*, **595**, 1-23 (1931).
4. ———. Home-made sauerkraut. N. Y. Agr. Expt. Sta. *Cir.*, **123**, 1-4 (1932).
5. Society of American Bacteriologists, *Manual of Methods for Pure Culture Study of Bacteria*. 9th ed., 1948, Biotech Publication, Geneva, New York.

Time-Temperature Relationships for Heat Inactivation of Pectinesterase in Citrus Juices[a]

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Percentage inactivation of pectinesterase is presented for Parson Brown, Pineapple, and Valencia orange juices, pH 3.5 and 4.1, Duncan grapefruit, pH 3.3 and 3.8, and Dancy tangerine juice, pH 3.8 heated to various temperatures from 125° F. (51.5° C.) to 210° F. (99.0° C.) with retention times in the pasteurizer of 12, 6, and 3 seconds.

The application of heat to citrus juices before concentration materially reduces the pectinesterase activity, depending upon the temperature obtained and the length of exposure time. The authors have reported *(3, 4)* on the reduction of the enzyme when citrus juices were heated to temperature in 0.8 second with retention times outside the pasteurizer. Data have also been presented *(1)* on the reduction or prevention of clarification and gelation based upon the percentage inactivation of the pectinesterase. Because of differences in the length of time required commercially to bring juices to a desired temperature, it was necessary to accumulate inactivation data pertinent to most present methods of heat treatment.

It was the purpose of this investigation to obtain data on the percentage inactivation of pectinesterase in citrus juices at several pH levels when retained in the pasteurizer for 12, 6, and 3 seconds, these being the times required to heat the juices from room temperature to the desired temperatures.

EXPERIMENTAL PROCEDURE

The juices were prepared by extracting the juice, pulp, and seeds with moderate pressure using a Rotary press. The seeds were separated by a rotating reel and the juice finished in a Food Machinery, Model 35, finisher with an 0.030-in. perforated screen to yield juice of 8% or 10% pulp by volume as preferred. The finished juices were deaerated and cooled in an ammonia-jacketed deaerator with the juices exposed to a vacuum of 27 in. for one hour during the cooling process. The prepared juices were placed in 10-gallon cans, drums, frozen and stored at −8° F. (−22° C.) until needed. Prior to heat treatment tests, the juices were thawed and passed through a Weil turbine pump to obtain homogeneous mixture of juice and pulp. Because of the grinding action of the pump the juices reached a temperature of 100° F. (38° C.); however, they were immediately cooled to room temperature.

For heat treatment the juices were pumped through a pasteurizer which contained three heating coils of ⅛-in. (internal diameter) stainless steel tubing. Hot water was circulated around the heating coils. The flow rate of the juice was adjusted in each tube to 560 ml. per minute. The juices were in contact with heat in the ⅛-in. tubes for 12, 6, and 3 seconds, the time required to raise the juice from room temperature to the desired temperature. All samples were cooled instantly by flashing under vacuum into small receptacles. Temperatures were controlled by a Brown potentiometer pyrometer and checked with a Bureau of Standards certified thermometer.

Methods of analyses were identical to those previously described *(3, 4)*, in which the pectinesterase method was essentially that of MacDonnell, Jansen, and Lineweaver *(2)*. Pectinesterase units represent the milliequivalents of ester hydrolyzed per minute per ml. per degree Brix (per g. soluble solids).

EXPERIMENTAL RESULTS AND DISCUSSION

Effect of varying temperatures and retention times in the pasteurizer on inactivation of pectinesterase in Parson Brown, Pineapple, and Valencia orange juices. Percent inactivation of the enzyme in orange juices, pH 3.5 and 4.1, containing 8% pulp by volume, is presented in Tables 1, 2, and 3. Temperatures to which the juices were subjected ranged from 125° F. (51.5° C.) to

TABLE 1
Percentage inactivation of pectinesterase in Parson Brown orange juice, pH 3.5 and 4.1, heated to temperature in 12, 6, and 3 seconds

Retention time		12 seconds		6 seconds		3 seconds	
Temperature		Inactivation		Inactivation		Inactivation	
		pH 3.5	pH 4.1	pH 3.5	pH 4.1	pH 3.5	pH 4.1
°F.	°C.	%	%	%	%	%	%
125	51.5	12.8	8.3	5.4	2.9	1.9	0.0
135	57.0	44.2	13.6	27.0	11.4	13.1	8.8
145	63.0	83.8	34.8	70.2	23.6	46.3	16.0
155	68.5	89.4	70.2	83.8	54.5	80.1	31.7
165	74.0	91.6	89.0	89.6	81.6	89.0	68.1
175	79.5	93.1	92.7	91.0	90.8	90.7	89.0
185	85.0	96.6	93.9	93.1	92.7	92.9	92.1
190	88.0	98.6	95.2	94.5	94.0	94.3	94.0
195	90.5	100.0	97.0	97.9	97.0	97.9	95.2
200	93.5		100.0	100.0	98.1	98.6	97.0
205	96.0				100.0	100.0	98.8
210	99.0						100.0

TABLE 2
Percentage inactivation of pectinesterase in Pineapple orange juice, pH 3.5 and 4.1, heated to temperature in 12, 6, and 3 seconds

Retention time		12 seconds		6 seconds		3 seconds	
Temperature		Inactivation		Inactivation		Inactivation	
		pH 3.5	pH 4.1	pH 3.5	pH 4.1	pH 3.5	pH 4.1
°F.	°C.	%	%	%	%	%	%
125	51.5	16.7	5.3	8.8	0.0	3.9	0.0
135	57.0	49.0	11.5	28.4	7.1	16.7	0.0
145	63.0	88.2	31.9	77.5	23.9	57.8	15.0
155	68.5	90.2	71.7	89.2	53.1	88.2	35.4
165	74.0	93.1	82.6	92.2	80.5	90.2	69.0
175	79.0	94.1	90.3	93.1	89.4	92.2	86.7
185	85.0	98.0	92.9	94.1	91.2	94.1	90.8
190	88.0	100.0	94.7	98.0	92.9	96.1	91.5
195	90.5		96.5	100.0	94.7	98.0	94.3
200	93.5		98.2		98.2	100.0	95.0
205	96.0		100.0		100.0		98.2
210	99.0						100.0

[a] Cooperative research by the Florida Citrus Commission and Florida Citrus Experiment Station, aided by a grant from the American Can Company. Florida Agricultural Experiment Station Journal Series, No. 182.

[b] Florida Citrus Commission.

[c] Florida Citrus Experiment Station.

TABLE 3

Percentage inactivation of pectinesterase in Valencia orange juice, pH 3.5 and 4.1, heated to temperature in 12, 6, and 3 seconds

Retention time		12 seconds		6 seconds		3 seconds	
Temperature		Inactivation		Inactivation		Inactivation	
		pH 3.5	pH 4.1	pH 3.5	pH 4.1	pH 3.5	pH 4.1
°F.	°C.	%	%	%	%	%	%
125	51.5	7.5	3.9	4.3	1.0	1.1	0.0
135	57.0	33.0	8.7	20.2	2.9	4.3	0.0
145	63.0	77.7	14.4	58.5	8.7	34.0	4.3
155	68.5	81.9	43.3	77.7	19.2	74.5	7.8
165	74.0	90.4	77.9	90.2	59.6	90.2	37.9
175	79.5	94.7	90.4	93.6	84.6	92.6	72.4
185	85.0	97.9	93.3	94.7	91.4	93.6	87.9
190	88.0	100.0	95.2	96.8	93.3	95.7	91.4
195	90.5		96.2	100.0	95.2	98.9	92.2
200	93.5		99.0		98.1	100.0	95.7
205	96.0		100.0		99.0		98.3
210	99.0				100.0		100.0

210° F. (99.0° C.). Pectinesterase varied in the unheated Parson Brown orange juice from 0.0129 to 0.0155 units, in the unheated Pineapple orange juice from 0.0102 to 0.0113 units, and in the unheated Valencia orange juice from 0.0092 to 0.0116 units.

Inactivation of pectinesterase in Parson Brown orange juice of pH 3.5, heated to 145° F. (63.0° C.), was 83.8% for 12 seconds, 70.2% for 6 seconds, and 46.3% for 3 seconds retention time in the pasteurizer. With the same pH and similar heat treatment, 88.2, 77.5, and 57.8% reduction in pectinesterase was obtained for the Pineapple orange juice and 77.7, 58.5, and 34.0% for the Valencia orange juice. Less inactivation of pectinesterase occurred with shorter retention times, but this was pronounced only at the lower temperatures.

Complete inactivation of the enzyme in Parson Brown orange juice, pH 3.5, was obtained at 195° F. (90.5° C.), 200° F. (93.5° C.), and 205° F. (96.0° C.) when retention times in the pasteurizer were 12, 6, and 3 seconds, respectively. A rise in pH of the Parson Brown juice to 4.1 required increased temperatures of 200° F. (93.5° C.), 205° F. (96.0° C.), and 210° F. (99.0° C.) for complete inactivation at the respective retention times. Pineapple and Valencia orange juices, pH 3.5, heated in 12, 6, and 3 seconds showed complete inactivation of pectinesterase at 190° F. (88.0° C.), 195° F. (90.5° C.), and 200° F. (93.5° C.), respectively; while these juices, pH 4.1, were inactivated at either 205° F. (96.0° C.) or 210° F. (99.0° C.).

Effect of varying temperatures and retention times in the pasteurizer on the inactivation of pectinesterase in Duncan grapefruit and Dancy tangerine juices. Pectinesterase activity of the unheated Duncan grapefruit juices, containing 8% pulp by volume, varied from 0.0122 to 0.0125 units, while the activity of unheated Dancy tangerine juice with 10% pulp was 0.0029 units.

Data on partial and complete inactivation of pectinesterase in Duncan grapefruit and Dancy tangerine juices are presented in Tables 4 and 5, respectively. Partial inactivation of pectinesterase obtained in Duncan grapefruit juice, pH 3.3, heated to 135° F. (57.0° C.) was 78.8, 64.3, and 55.2%, with 12, 6, and 3 seconds retention times, respectively. Complete inactivation of the enzyme was obtained when grapefruit juices of pH 3.3 and 3.8 were heated in 12 seconds to 190° F. (88.0° C.) and 195° F. (90.5° C.), 6 seconds to 195° F. (90.5° C.), and 200° F. (93.5° C.), and 3 seconds to 200° F. (93.5° C.) and 205° F. (96.0° C.).

Dancy tangerine juice, pH 3.8, heated in 12, 6, and 3 seconds to 155° F. (68.5° C.) gave 74.1, 64.2, and 57.7% inactivation of the enzyme, respectively. For complete inactivation of the pectinesterase in tangerine juice, a temperature of 195° F. (90.5° C.) was required for 12 seconds, 200° F. (93.5° C.) for 6 seconds, and 205° F. (96.0° C.) for 3 seconds retention time in the pasteurizer.

TABLE 4

Percentage inactivation of pectinesterase in Duncan grapefruit juice, pH 3.3 and 3.8, heated to temperature in 12, 6, and 3 seconds

Retention time		12 seconds		6 seconds		3 seconds	
Temperature		Inactivation		Inactivation		Inactivation	
		pH 3.3	pH 3.8	pH 3.3	pH 3.8	pH 3.3	pH 3.8
°F.	°C.	%	%	%	%	%	%
125	51.5	48.7	22.0	40.7	17.2	36.7	0.0
135	57.0	78.8	28.3	64.3	22.8	55.2	1.6
145	63.0	82.7	72.1	82.0	32.3	80.4	18.8
155	68.5	88.1	82.6	86.8	76.4	85.3	55.8
165	74.0	89.9	86.7	88.8	84.4	86.9	81.7
175	79.5	93.9	90.7	92.4	90.7	90.1	86.0
185	85.0	96.2	94.6	93.9	92.3	92.4	88.5
190	88.0	100.0	97.2	97.7	96.1	94.7	92.4
195	90.5		100.0	100.0	98.4	98.5	96.2
200	93.5				100.0	100.0	98.4
205	96.0						100.0

TABLE 5

Percentage inactivation of pectinesterase in Dancy tangerine juice, pH 3.8, heated to temperature in 12, 6, and 3 seconds

Rentention time		12 seconds	6 seconds	3 seconds
Temperature		Inactivation	Inactivation	Inactivation
		pH 3.8	pH 3.8	pH 3.8
°F.	°C.	%	%	%
125	51.5	18.1	16.4	13.0
135	57.0	31.7	24.0	20.5
145	63.0	57.7	44.4	35.2
155	68.5	74.1	64.2	57.7
165	74.0	80.6	75.8	74.1
175	79.5	84.0	80.6	78.5
185	85.0	87.4	84.0	81.6
190	88.0	93.5	90.4	86.7
195	90.5	100.0	93.5	92.2
200	93.5		100.0	93.9
205	96.0			100.0

SUMMARY

Relationships for heat inactivation of pectinesterase in Parson Brown, Pineapple, and Valencia orange juices, Duncan grapefruit juice, and Dancy tangerine juice were determined. With retention times of 12, 6, and 3 seconds in the pasteurizer, complete inactivation of pectinesterase in orange juices, pH 3.5, was obtained at 190° F. (88.0° C.) to 205° F. (96.0° C.); whereas in juices with pH 4.1, temperatures of 200° F. (93.5° C.) to 210° F. (99.0° C.) were required. In

Duncan grapefruit juice, pH 3.3 and 3.8, pectinesterase was completely inactivated at temperatures of 190° F. (88.0° C.) to 205° F. (96.0° C.) depending upon the heating time. Dancy tangerine juice pH 3.8, heated in 12, 6, and 3 seconds to 195° F. (90.5° C.), 200° F. (93.5° C.), and 205° F. (96.0° C.), respectively, showed complete inactivation of pectinesterase.

LITERATURE CITED

1. Atkins, C. D., Rouse, A. H., Huggart, R. L., Moore, E. L., and Wenzel, F. W. Gelation and clarification in concentrated citrus juices. III. Effect of heat treatment of Valencia orange and Duncan grapefruit juices prior to concentration. *Food Technol.*, **7**, 62 (1953).

2. MacDonnell, L. R., Jansen, E. F., and Lineweaver, H. The properties of orange pectinesterase. *Arch. Biochem.*, **6**, 389 (1945).

3. Rouse, A. H., and Atkins, C. D. Heat inactivation of pectinesterase in citrus juices. *Food Technol.*, **6**, 291 (1952).

4. Rouse, A. H., and Atkins, C. D. Further results from a study on heat inactivation of pectinesterase in citrus juices. *Food Technol.*, **7**, 221 (1953).

A Comparison of Scoring Methods for Taste Tests with Mealiness of Potatoes

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Three methods of scoring taste tests, ranking, grading, and checking descriptive terms, have been compared in rating six varieties of potatoes for mealiness. The rank order of test means showed no differences between scoring techniques, but analyses of variance and of covariance of the observed scores favored ranking as the most sensitive and distinguished it from either grading or checking, with checking the least sensitive.

A common objective in tase testing is to place a number of varieties in order on a linear scale and then to determine the significance of the differences between them. One approach is to compare the varieties two at a time in all possible pairs, and then arrange them in sequence from the number of times each is preferred in the series of paired comparisons. A linear scale may be developed when the record shows only the order of preference within each pair *(10, 13)*, or when the degree of preference is reported as well *(12)*.

When sensory fatigue is not a limiting factor, there is a more efficient design. This is to present all of the varieties to each subject in a single series and ask him to score them on some scale. As further conditions, the order of tasting is randomized, the number of varieties does not exceed 6 or 8, and the test arrangements are standardized. The most effective method of scoring this type of test is still an open question. Three techniques in common use are ranking in order of the intensity of some characteristic, grading on an absolute scale of equal-appearing intervals, and checking descriptive terms. Although each has its advocates *(3)*, the 3 alternatives have seldom been compared directly. In one case where ranking and grading were compared in rating samples of apple juice for acidity, the 2 methods did not differ *(2)*.

After reviewing the variability in scoring procedure, a direct comparison of the 3 scoring methods was recommended by a conference in February, 1950, of technical workers in Home Economics from the northeastern region of the Association of Land-Grant Colleges and Universities. The present project on the relative mealiness of 6 varieties of potatoes is an outgrowth of this recommendation. The potatoes in each test were grown in the same field and scored in respect to the single characteristic by 12 subjects, each using all 3 scoring methods. Measurements of the specific gravity of the tubers used in the experiment have been compared with scores determined by grading and reported elsewhere *(5)*. Here we are concerned with a comparison of the 3 systems of scoring.

EXPERIMENTAL PROCEDURE

Test potatoes were grown in the unusually dry summer of 1949 by the Plant Science Department, Storrs Agricultural Experiment Station, on 2 farms in the Connecticut River Valley, one irrigated and one not irrigated. Eight varieties were planted on each farm in an 8 x 8 Latin square, each plot being harvested separately, labelled and stored in a vegetable cellar until needed. Six of the varieties were compared for mealiness: Green Mountain, Katahdin, Kennebec, Mohawk, Ontario and Chippewa, the first and last representting extremes in specific gravity.

Samples for a single day's test represented one row from one of the field Latin squares, since a preliminary study showed that specific gravity varied somewhat less within rows than within columns. On any given day, the 6 samples, one from each variety, were presented under code numbers to all of the subjects in the same order, selected at random. Two initial tests, representing 2 rows from the irrigated field (Farm H) served as trial runs, followed by 6 definitive tests on separate days from the other rows in the same Latin square. Six rows from the Latin square on the non-irrigated field (Farm M) supplied samples for the other 6 tests reported here, although 2 later tests utilized potatoes from the remaining 2 rows in the field.

A single test required 4 potatoes of each variety. The potatoes were quartered raw and cut into one-half inch cubes, leaving the skins intact. Each potato was reassembled as shown in Figure 1 and wrapped in aluminum foil. After piercing with a fork to allow the escape of steam, the potatoes were baked at 425° F. until tender as determined with a cake tester. To broaden the basis for assigning scores without changing the original texture, subjects were asked to taste a cube from each of the 4 tubers of each variety before forming a final judgment as to mealiness. The subjects were students and staff members in the School of Home Economics, University of Connecticut.

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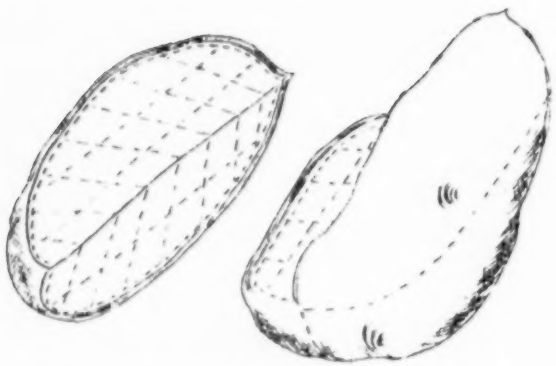

Figure 1. Diagram of potato as prepared for sampling.

The methods of scoring were ranking, grading and checking descriptive terms. In ranking, the subjects ranked the samples in order of decreasing mealiness from 1 to 6, no ties being permitted. For analysis, these ranks were transformed to scores for normalizing ordinal data *(4)*, *scores* of 1.27, .64, .20, —.20, —.64 and —1.27 corresponding to ranks of 1 to 6 respectively. In grading, the varieties were scored on an absolute scale of increasing mealiness from one to 10 and analyzed in these units. In checking descriptive terms, the original designations were very watery, watery, slightly watery, neither mealy nor watery, slightly mealy, mealy, and very mealy. For analysis, these were assigned numerical scores of 1 to 7 respectively.

Since the 3 methods of scoring would be expected to differ but little if at all, it was essential to segregate any variation among subjects, rows of field plots and test days in designing the experiment. Sensory fatigue made it impossible for a subject to score the 6 varieties on a given day with more than one method. Moreover, for any one individual, direct comparisons between days would be confounded with differences between rows of plots in the field, as well as with day-to-day variations in taste acuity. These two-fold limitations were met by arranging the taste tests in unit 3 x 3 Latin squares, in which individual subjects represented the columns, day of test the rows, and letters the method of scoring. With 12 subjects, the experiment fell naturally into 4 concurrent 3 x 3 Latin squares for scoring the potatoes from each set of 3 rows in the field. The basic design is shown in Table 1.

With this design, a comparison of the 3 methods on a single day was confounded with differences between individuals. Similarly, methods compared on the same individual would be confounded both with differences between days and with heterogeneity between the rows of field plots. In consequence, the unit for analysis was the sum of the 3 scores for each variety as recorded by each method in an individual 3 x 3 Latin square. On the assumption of additivity, the differences between rows and columns within each square cancelled out, giving comparable sums. In the analysis, the 16 replicate sums for each variety were converted by suitable divisors to units of a single score.

TABLE 1

Latin square design showing the method of scoring used by each taster for potatoes from the irrigated Farm H (tests 3 to 8) and from Farm M without irrigation (tests 9 to 14), where a = ranking, b = grading and c = checking descriptive terms

Test No.	Date 1950	Taster No.											
		1	2	3	4	5	6	7	8	9	10	11	12
3	3/30	c	a	b	b	c	a	a	b	c	b	c	a
4	4/10	a	b	c	a	b	c	b	c	a	a	b	c
5	4/14	b	c	a	c	a	b	c	a	b	c	a	b
6	4/19	c	a	b	b	c	a	a	b	c	b	c	a
7	4/20	a	b	c	a	b	c	b	c	a	a	b	c
8	4/26	b	c	a	c	a	b	c	a	b	c	a	b
9	4/27	c	a	b	b	c	a	a	b	c	b	c	a
10	5/4	a	b	c	a	b	c	b	c	a	a	b	c
11	5/5	b	c	a	c	a	b	c	a	b	c	a	b
12	5/10	c	a	b	b	c	a	a	b	c	b	c	a
13	5/11	a	b	c	a	b	c	b	c	a	a	b	c
14	5/13	b	c	a	c	a	b	c	a	b	c	a	b

Effect of order of tasting. In some taste experiments, the order of testing has seemed to influence the score assigned by the subjects *(3)*. This possibility was examined by a preliminary analysis of covariance on the effect of order. Since the 6 varieties were tasted in the same order on any one day but in a different random order on different days, the test on a single day served here as the unit rather than their sums in the 3 x 3 Latin squares. A separate analysis of covariance was computed for each scoring technique from the 8 tests on each farm, retaining in the error interaction of test by variety only the variation among tests *within* the 3 groups of tasters. Thus in each analysis, differences among varieties, with 5 degrees of freedom, were compared with the variety by test interaction within taster groups, with 25 degrees of freedom. If the score for mealiness depended in a simple manner upon its position in the order of tasting, it should be possible to approximate the relation with a parabola. Accordingly, the effect of order was represented by 2 sets of orthogonal coefficients *(4)* — $x_1 = -5, -3, -1, 1, 3, 5$ and $x_2 = 5, -1, -4, -4, -1, 5$ — as the concomitant variates in covariance, the first (x_1) measuring the linear trend on order and the second (x_2) simple or quadratic curvature in the trend.

Any real effect of order should have resulted either in a significant reduction in the variance ratio F for varieties or in a smaller mean square for the interaction of varieties by tests within taster groups. Neither occurred. Although the variance ratio for varieties was reduced slightly by covariance on order in 5 of the 6 analyses, in no case was the reduction of importance. With both ranking and checking, removing the effect of order from the interaction increased rather than decreased the residual variance. With grading, the slope on order was larger than the residual mean square for error, but in one farm it was positive, in the other it was negative and in neither was it significant. Since order of presentation had no appreciable effect upon the scores assigned in the present experiment, this factor has not been considered further.

The comparison of varieties. The potato varieties selected for testing were believed from past experience to differ in mealiness. The mean score for each variety in both farms is summarized in Table 2 for each method of scoring. Ranks have been converted to mean deviates before averaging but no transformations have been applied to the scores for grading and checking. In a study of subjective appraisals by grading, Hopkins *(9)* found a significant relation between the original mean grade for a foodstuff and its variance, but was able to stabilize the variance with a suitable transformation. This need did not arise in the present experiment. As shown by the frequency distributions of the individual scores in Table 3, the 6 varieties covered the full range of mealiness for both grading and checking with no marked reduction in the variability of low and high scoring varieties. The varietal means, of course, varied less from one another than the individual scores within varieties.

TABLE 2

Mean scores for mealiness of six varieties of potatoes for each method of scoring in each farm

Variety	Farm H			Farm M		
	Ranking	Grading	Checking	Ranking	Grading	Checking
A	.840	5.96	5.00	.706	6.83	5.08
B	—.166	4.08	3.88	—.018	5.25	4.33
C	.130	4.83	3.88	.236	5.00	4.21
D	.282	5.50	4.58	—.235	3.96	3.67
E	—.353	3.96	3.75	—.275	4.25	3.71
F	—.731	4.08	3.38	—.415	3.25	2.88
Mean	0	4.74	4.08	0	4.76	3.98

Varieties: A = Green Mountain, B = Katahdin, C = Kennebec, D = Mohawk, E = Ontario, F = Chippewa.

The difference in unit precluded any direct comparison of scoring methods, but if we disregard the magnitude of the differences on each scale, the varietal means for each series of tests

TABLE 3

Frequency distributions of the individual scores in each farm for each potato variety (A to F) and method of scoring

Scoring method	Score	No. of scores on Farm H for A	B	C	D	E	F	No. of scores on Farm M for A	B	C	D	E	F
Ranking	−1.27		3		2	5	14	1	5		7	4	7
	−.64		7	4	1	8	4	1	3	4	1	9	6
	−.20	3	6	4	5	4	2	1	4	2	8	4	5
	.20	2	2	10	7	3		3	5	8	2	3	3
	.64	6	4	5	3	3	3	7	2	9	4	1	1
	1.27	13	2	1	6	1	1	11	5	1	2	3	2
Grading	1	1	4		1	1	4		1	1	3	1	5
	2	2	2	3	2	2	4		2	1	2	3	4
	3	1	5	5	1	7	2		1	2	8	5	6
	4	1	4	5	4	6	3	2	5	2	5	8	4
	5	1	2	3	3	5	4	2	4	10	1	2	2
	6	8	4	3	5	2	3	6	4	5	1	2	1
	7	4		2	4		2	7	3	1	1	1	1
	8	5	2		1	1	2	3	3	2	2		1
	9		1	2	3			3	1			1	
	10	1		1				1			1	1	
Checking	1	1	2		1				1	1	1	1	2
	2		1	3	2	5	6	2	1	3	3	1	9
	3	3	5	4	2	9	8		5		6	8	7
	4	1	9	11	3	3	6	6	3	10	9	5	2
	5	6	4	5	10	2	3	5	11	7	3	4	4
	6	9	1	1	5	4	1	8	2	2	2	3	
	7	2			1	1		3	1	1			

within each farm and method could be ranked in order. The scoring methods were then compared by the analysis of variance in Table 4 in terms of transformed ranks. As expected, the varieties differed very markedly from one another, both on the average and between farms. The mean squares for the interaction of variety by method and of variety by method by farm were both less than the error variance. Hence the 3 methods of scoring agreed in placing the varieties substantially in the same rank order. On this basis, they were alike.

TABLE 4

Analysis of variance of the rank order of varieties in the total scores for each method in tests 3-5, 6-8, 9-11 and 12-14 respectively

	D.F.	M.S.	F
Varieties	5	6.550	24.71**
Varieties × farms	5	1.208	4.56**
Varieties × methods	10	0.144	0.54
Varieties × methods × farms	10	0.084	0.32
Remainder within farms	30	0.265	1.00

**P < .005.

Comparative analysis of the three scoring methods. Each method of scoring led to a different subjective scale of mealiness. Although the 6 varieties of potatoes were arranged in a similar order on each scale, their relative positions on these scales might have differed materially. Despite the difference in unit, their F ratios in similar analyses of variance would be comparable. In these terms, did the scoring techniques discriminate equally well, not only among varieties, but also among varietal differences on the 2 farms and in the 2 sets each of 3 tests on each farm?

Ranking lacked one type of comparison which was retained in grading and checking. With the 2 latter criteria, it was possible to measure differences in mean grade among taster groups, between farms, between tests within farms, and their interactions, averaged in each case over all varieties. In ranking, on the other hand, these averages were necessarily the same, but one may question whether any real information was lost. On either the grading or checking scales, the absolute mean of a given variety would be reliable for comparison with a mean from another experiment only if both tests included the same stable standard, a near impossibility with an unprocessed food such as baked potatoes. In the present tests, none of the differences between the mean values combining the 6 varieties would be considered to have differed significantly with either grading or checking. Hence this aspect was not considered further.

Differences among varieties and varietal interactions with the other factors in the experiment have been compared in Table 5. For comparing varietal means, the sum of the first order interactions of varieties with farms and with tests in farms totalling 15 degrees of freedom served as the error. For all other comparisons, each error combined 2 second order interactions of equal magnitude (not shown separately) totalling 45 degrees of freedom, that of farm by varieties by groups and that of farm by varieties by tests. The 6 varieties rated differently on the 6 farms with both grading and ranking but not with checking. Differences between groups of subjects and between successive tests on the 2 farms were discriminated with ranking but not with grading or checking. The comparative F values suggest that ranking had greater sensitivity than grading and grading greater sensitivity than checking.

TABLE 5

Analysis of variance of the total scores from each 3 × 3 unit square in Table 1 for each method of scoring

	D.F.	Ranking M.S.	Ranking F	Grading M.S.	Grading F	Checking M.S.	Checking F
Varieties	5	10.238	8.45 [d]	41.69	6.71 [d]	18.70	7.53 [d]
Varieties × farms	5	1.018	3.03 *	12.30	3.31 *	3.27	1.98
Var. × tests in farms	10	1.309	3.90 [d]	3.17	0.85	2.09	1.26
Var. × taster groups	15	0.706	2.10 *	2.42	0.65	1.66	1.00
2nd order interactions	45	0.336		3.71		1.66	
Error for varieties [c]	15	1.212		6.21		2.48	

[c] Varieties × farms + varieties × tests in farms. [d] Significant at P < .005. * Significant at P < .025.

Covariance between methods. The mean squares and F values in Table 5 do not show whether the 3 methods supplied different kinds of information or merely different amounts of the same kind. The comparisons in Table 4 suggest the latter, but finer and possibly important differences were sacrificed there for simple rank order. The scale for each method should contribute to any decision as to its suitability for this type of taste test. Covariance filled this need.

Two basic comparisons were computed. In the first, varieties were compared against an error term consisting of the interaction of varieties by farms and of varieties by tests within farms. In the second, the variety by farm interaction was compared against the second order interactions defined in the preceding section. Covariance tested the hypothesis that ranking gave no information about either type of varietal difference that was not already provided by grading and checking. If this null hypothesis were true, an initial significance in terms of ranks would vanish when the ranks were adjusted by covariance for the other two types of score. However, if it were false and ranking provided additional information, the differences among varieties or the variety by farm interaction should still be significant, after removing the effects of the other two criteria. The calculation was repeated for grading and for checking, correcting each criterion in turn by the other two.

The results are shown in terms of the reduced mean squares and F values in Table 6. After removing the information provided by the other 2 criteria, none of the mean squares for varieties approached significance. Given the average mealiness of each variety by any 2 methods, no information was added by the third. The reduced mean square for the interaction of variety by farm, however, was significant at the 1% level for ranking but not significant for either grading or checking. Hence,

TABLE 6

Reduced mean squares for each method of scoring after removing by covariance the effects of the other two methods

	D.F.	Ranking Reduced M.S.	Ranking F	Grading Reduced M.S.	Grading F	Checking Reduced M.S.	Checking F
Varieties	5	1.214	1.53	.721	0.26	2.687	1.68
Error [f]	13	.794	1.00	2.753	1.00	1.596	1.00
Varieties × farms	5	1.190	3.70 [b]	6.399	1.80	1.897	1.29
Error [g]	43	.322	1.00	3.546	1.00	1.465	1.00

[f] Varieties × farms + varieties × tests in farms. [g] 2nd order interactions. [b] Significant at P < .01.

neither grading nor checking supplied any information that was not already present in ranking and in one of the other 2 measures. Ranking, however, did supply new evidence.

The analyses were then recomputed, in each case with a single concomitant measure. The results are shown in Table 7 in terms of the F values for varieties and for varieties by farms, compared in each case against error terms similar to those in Table 6. All 3 scoring methods were of nearly equal effectiveness in accounting for the average mealiness of the 6 varieties,

TABLE 7

Variance ratios (F) computed from the mean squares reduced by covariance, with error mean squares based upon 14 degrees of freedom for varieties and upon 44 degrees of freedom for varieties × farms. The trends between scores were determined in each case from the terms for error, with errors defined as in Table 6

Score	D.F.	F values for	
		Varieties	Varieties × farms
Ranking with grading removed	5	1.01	3.08
Grading with ranking removed	5	.43	3.36
Trend between scores	1	6.89	.50
Ranking with checking removed	5	2.34	3.88
Checking with ranking removed	5	1.92	2.77
Trend between scores	1	.08	4.06
Grading with checking removed	5	.84	1.93
Checking with grading removed	5	1.15	.76
Trend between scores	1	7.29	4.16
Tabular F at P = .05	5	2.96	2.59
	1	4.60	4.06

with ranking and checking diverging the most. In comparing varieties for differences in mealiness on the 2 farms, however, ranking was not equivalent to either grading or checking, which, in turn, gave similar results. The same distinctions were apparent in the amount of variation removed from each error by the trend of one score on the other. There was no relation between the scores for ranking and for checking in the error for varieties, or between the scores for ranking and for grading in the error for varieties by farms. All other scores were correlated significantly, again emphasizing the closer agreement of grading and checking than of either with ranking.

DISCUSSION

The present tests have shown a difference in sensitivity among the three scoring methods, even though all of them placed the 6 varieties in essentially the same order of mealiness on each farm. If only the rank order were required, the choice of method could be based on other considerations. The untrained taster and probably even one with training may find it more difficult to grade on an absolute numerical scale than to rank or to check descriptive terms. Both the numerical grades and the descriptive terms assume a standard against which all samples are judged, but it may be impossible to include a uniform standard in each test, and memory is not infallible. So far as the subject is concerned, ranking sets its own standard in each test, the assigned scores being merely relative values. Although it disregards degrees of difference, ranking reduces the effect of a "perverted" taster who might assign a grade of 0 in the absence of a standard *(8)*. When a standard is available, it can be included among the unknowns with all 3 methods *(2)*, as a reference point on the same scale as the other products in the test. If sensory fatigue is not a limitation, 2 standards may be advisable, one labelled as a reference and its duplicate hidden in the series to be tested *(8)* or, alternatively, one near each end of the absolute scale. This proviso would facilitate direct comparisons from one series of experiments to another.

So far as the computation is concerned, ranking is the simplest since ranks can be transformed to scores that are already normal deviates from the mean. With grading on the other hand, 2 complications may disturb the analysis, although they were not a factor in the present experiment. The variance may be related to the varietal mean and require a special transformation *(9)*. More seriously, judges may differ both in the section of the scale from which they assign grades and in the extent to which their judgments cover the scale of grades *(11)*. The second factor particularly could complicate an analysis. Both restrictions would apply equally to the checking of descriptive terms. For ease of statistical analysis, therefore, ranking would be preferred to either grading or checking and has been used effectively in factorial designs *(7)*, in determining maxima *(1)* and in balanced incomplete blocks *(6)*.

SUMMARY

The performance of 3 scoring methods for taste tests has been compared in an experiment on rating potatoes for mealiness. Six varieties were grown in a relatively dry summer on 2 farms, one with and the other without irrigation and tested separately the following spring. The 6 varieties were presented to 12 subjects, who did the tasting, in a different random order in each of 12 tests. A preliminary analysis of covariance showed no effect of order upon the score. The 6 varieties were rated by all 3 methods in every test, each method by 4 subjects. The experiment was arranged in a 3 x 3 Latin square, so as to balance differences between subjects and days within each unit square.

The 3 methods for scoring mealiness were ranking in order, grading each variety on an absolute scale of 1 to 10, and checking against a series of 7 descriptive terms. Ranks were transformed to normal deviates for analysis, but grading and checking showed no heterogeneity in the variance which required a transformation. The rank order of the varietal means differed significantly, both in their overall averages and in the interaction of varieties by farms. In both comparisons, the scoring methods agreed well.

The actual scores as contrasted with the ranks of the means were examined by a separate analysis of variance for each scoring method. From a comparison of their F ratios, ranking gave the largest number of significant mean squares and checking the smallest number.

An analysis of covariance showed that no scoring method supplied any additional information about varietal means not provided by either of the others. However, an extension of the same technique to the interaction of varieties by farms indicated a closer similarity between grading and checking than between either of them and ranking. Removing the information in either grading or checking or in both by covariance left a significant remainder in the rank scores for this interaction. The greater sensitivity of ranking was paralleled apparently by a qualitative difference from either grading or checking, with grading more effective than checking.

LITERATURE CITED

1. Bliss, C. I., Anderson, E. O., and Mariand, R. E. A technique for testing consumer preferences, with special reference to the constituents of ice cream. Storrs Agr. Expt. Sta. *Bull. 251* (1943).
2. Dawson, E. H., and Dochterman, E. F. A comparison of sensory methods of measuring differences in food qualities. *Food Technol.*, **5**, 79 (1951).
3. Dawson, E. H., and Harris, B. L. Sensory methods for measuring differences in food quality. U. S. Dept. Agr., Agr. Information *Bull. 34* (1951).
4. Fisher, R. A., and Yates, F. Statistical Tables for Biological, Agricultural and Medical Research. Fourth ed., 1953, Oliver and Boyd, London.
5. Greenwood, M. L., McKenrick, M. H., and Hawkins, A. The relationship of the specific gravity of six varieties of potatoes to their mealiness as assessed by sensory methods. *Am. Potato J.*, **29**, 192 (1952).
6. Greenwood, M. L., Potgieter, M., and Bliss, C. I. The effect of certain prefreezing treatments on the quality of eight varieties of cultivated highbush blueberries. *Food Research*, **16**, 154 (1951).
7. Greenwood, M. L., and Salerno, R. Palatability of kale in relation to cooking procedure and variety. *Food Research*, **14**, 314 (1949).
8. Harrison, S., and Elder, L. W. Some applications of statistics to laboratory taste testing. *Food Technol.*, **4**, 434 (1950).
9. Hopkins, J. W. A procedure for quantifying subjective appraisals of odor, flavor and texture of foodstuffs. *Biometrics*, **6**, 1 (1950).
10. Mosteller, F. Remarks on the method of paired comparisons: III. A test of significance for paired comparisons when equal standard deviations and equal correlations are assumed. *Psychometrika*, **16**, 207 (1951).
11. Overman, A., and Li, J. C. R. Dependability of food judges as indicated by an analysis of scores of a food-tasting panel. *Food Research*, **13**, 441 (1948).
12. Scheffe, H. Analysis of variance for paired comparisons. *J. Am. Stat. Assoc.*, **47**, 381 (1952).
13. Terry, M. E., Bradley, R. A., and Davis, L. L. New designs and techniques for organoleptic testing. *Food Technol.*, **6**, 250 (1952).

Observations on Fresh Meat Processed by the Infusion of Antibiotics[a]

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Processing of fresh meat may be limited by the initial refrigeration required to prevent internal spoilage (sours). Studies on the bacterial populations in the muscle, lymph nodes, and bone marrow of beef and on the effect of retarding spoilage in ground beef by the use of antibiotics indicated that beef might be held without immediate refrigeration if processed by infusion of antibiotics. Twenty-three paired rounds and seven whole animals were infused with saline containing aureomycin so as to put approximately 2 p.p.m. of the antibiotic into the meat. Aureomycin was determined in the meat at various times after slaughter and after 72 hours post mortem all antibiotic has disappeared. Non-infused mated rounds contained more organisms than infused rounds when both were refrigerated. When refrigeration was delayed 48 to 72 hours post mortem, a majority of the control rounds soured whereas the infused rounds remained in good condition. When whole animals were infused and dressed out, no sides spoiled even though held out of refrigeration for 48 hours. The non-refrigerated side was more tender than the refrigerated side. No flavor differences were induced by the infusion. Some color improvement was noted in the non-refrigerated side.

Present knowledge of the biochemistry and physiology of animals used for meat presents the possibility of processing of fresh meat by infusion of the animal at slaughter to improve and standardize quality. The studies to be reported here are quite exploratory in nature and yet have given results which indicate some of the problems encountered in such procedures and also some of the possibilities of processing by infusion. In this work also some observations have been made which are of interest in other phases of present day meat processing.

The idea of processing meat by infusion is not new and has been widely practiced in ham curing in recent years. However, these studies have been pointed toward complete infusion of whole animals prior to dressing out. With the vascular system largely intact complete infusion is easily attained and without the use of excessive pressures which often rupture blood vessels. Furthermore, infusions conducted in this way are far more sanitary than infusions carried piece meal after evisceration.

Present day meat packing relies on artificial refrigeration. It is well known that to be on the safe side and prevent internal spoilage (sours) it is necessary that a carcass should be chilled to an internal temperature below 60° F. within 20 to 24 hours after slaughter. In some respects processing fresh meat is limited by the necessity of immediate chilling. If chilling could be delayed certain quality attributes might be improved. This is particularly true of tenderness and perhaps also for juiciness and flavor. If one is to investigate processing possibilities, it is necessary that ways and means be found to control deep spoilage.

DEEP SPOILAGE

It is not the purpose of the paper to review the literature on deep spoilage but to present a working hypothesis on which to approach the problem of fresh meat processing. From inspection of many soured rounds and hams it appeared that deep spoilage might be caused from organisms residing not in the skeletal

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muscle (meat) but in other tissues—mainly lymph nodes and bone marrow. Indeed the lymph nodes serve a phagocytic function in the animal.

In order to get information on this point, Lepovetsky, Weiser, and Deatherage *(8)* studied the bacterial populations in the lymph nodes, bone marrow, and skeletal muscle from 11 chucks and 12 rounds representing 23 cattle. Their results indicated that most of the bacteria in the deep tissues were in the lymph nodes.

The lymph nodes have excellent blood supplies and can be reached quite easily through the vascular system. The next question was what might be used to arrest bacterial growth in these tissues. The use of a broad spectrum antibiotic seemed to be a likely place to start since they are non-toxic and flavorless in the required amounts. Another possibility was altering the pH of the nodes by the use of buffers. Previous experience by S. A. Husaini *(6)* with buffers indicated that antibiotics would be simpler at least in these studies.

The next consideration was to select an antibiotic and to determine the necessary amount. The results of this phase of the problem have already been published by Goldberg, Weiser and Deatherage *(5)*. Much of the data reported here were obtained by the methods already described by these authors and will not be described here. Briefly stated, from studies on penicillin, streptomycin, bacitracin, aureomycin, Terramycin[b] and chloromycetin it was found that only the last 3 showed promise—aureomycin, terramycin and chloromycetin at 2.0 p.p.m. were effective in retarding spoilage in ground beef. These 3 antibiotics were then tested against the 92 different strains of organisms isolated from lymph nodes, bone and muscle tissue by Lepovetsky *et al.* with the result that aureomycin appeared to be the antibiotic of choice to begin the investigation of meat processing by infusion and to determine if deep spoilage could be arrested by infusing an antibiotic.

For reasons of economy it was decided to do some initial infusion studies using beef rounds only. Beef animals were slaughtered and dressed in the usually accepted manner. After splitting the carcasses the hot rounds were excised and used immediately. One round was infused while the other remained a control. The infusion was carried out using a Griffith pump such as is used for ham curing. A 10 gauge needle was used to cannulate the external iliac artery. Since an excised round has its vascular system cut in numerous places, somewhat elevated pressures were required to overcome leaking vessels (arteries) which could not be closed handily using hemostats.

The solution injected consisted of physiological saline made with 30 pounds of tap water (due to the lime softening process Columbus tap water is almost sterile 0-5 organisms per ml.) in which 0.75 g. aureomycin was dissolved. All equipment used had previously been sterilized with live steam. The resulting solution contained 55 p.p.m. of the antibiotic and the round was pumped to 10% increase in weight. At this time the hemostats were removed and the round was drained. 5.x to 7.5% of the original weight was retained. Infusing excised rounds is not too satisfactory. In order to be assured of complete infusion pressure was applied so that swelling of the knuckle and shank as well as the top of the round could be observed. The pressure was considerably more than normal blood pressure and there was some rupture of the small vessels. Both control and infused rounds were treated alike as far as refrigeration was concerned.

The first group of 8 paired rounds were placed immediately into a cooler at 3° C. for 48 hr. After this time the control and infused rounds were examined in detail. Both rounds were comparable in color, odor, taste, and pH, although the infused round appeared a bit more moist. The popliteal lymph nodes were examined for bacteria with the following results (Table 1). (In this table 30 indicates no organisms were found and the lower limit of counting was 30/g.). These data clearly indicated that the antibiotic was effective in reducing the bacterial populations in these nodes.

It was then decided that a second series of similar tests should be run but retarding refrigeration simply by keeping the rounds at room temperature (which was 75 to 85° F.) for 48 hours. The rounds darkened on the surface and if they didn't sour they were comparable in appearance and flavor. The bacterial counts on these rounds are shown in Table 2.

Seven out of 10 control rounds exhibited some or at least a little off odor at some point. However, all of the infused rounds were sound. Control rounds 13, 15 and *22* were sour. Figure 1 shows the lymph nodes from number 13.

Control round number *22* started puffing at 48 hours whereas the infused meat was sound after 76 hours at room temperature 80-85° F. Figure *2* shows these rounds.

The pH values of all rounds were between 5.50 and 5.60. Table *3* compares the moisture and total hemoglobin and myoglobin. Total hemoglobin and myoglobin was determined by converting to the methemoglobin and metmyoglobin and measuring absorption at 540 mμ *(1, 7)*.

As would be expected the infused beef contained on the average about 3.0% more water and contained less pigment due to flushing out the blood.

It seems desirable before proceeding to whole animals to determine if the mechanics of infusion might affect the number of organisms in the rounds. To do this 4 pairs of rounds were used, one round was infused with saline and the other was used as a control. On examination there were no significant differences in the numbers of organisms found in the popliteal lymph nodes, top round, shank and knuckle muscle tissue after holding

TABLE 1

Bacteria in the popliteal lymph nodes from infused and control paired rounds held in 3° C. cooler 48 hours post mortem

Round No.	Number of orgranisms per gram	
	Infused	Control
1	30	30
2	400	6000
3	30	30
4	30	450
5	30	1000
6	30	1600
7	30	1500
8	30	2000

TABLE 2

Bacteria in the popliteal lymph nodes, top round, and knuckle from infused and control paired rounds held at room temperature 25°-30° C. 48 hours post mortem

Round No.	Thousands of Bacteria/gram					
	Lymph nodes		Top round		Knuckle	
	Control	Infused	Control	Infused	Control	Infused
9	120	0.6	910	3	6,000	10
10	10	0.3	1,000	13	3,000	32
11	270	100	90	20	100	61
12	165	55	200	26	150	48
13	21,000	130	43	0.8	400	4.2
14	930	10	370	12	175	40
15	1,000	6.3	450	10	500	36
16	100	8.0	12	1.7	20	5
17	77	5.6	500	3	750	15
22	12,000	20	12,000	4	12,000	12

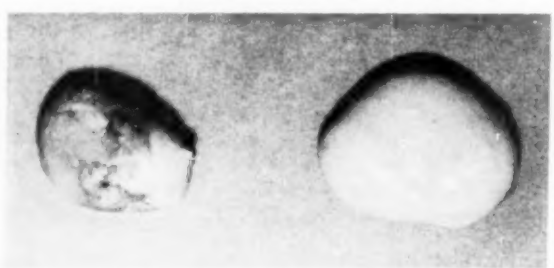

Figure 1. The popliteal lymph nodes from paired rounds No. 13 showing the discoloration due to bacteria in the control node on the left and the normal looking node from the infused round on the right.

[b]Terramycin is the trade mark for the antibiotic oxytetracycline; registration was granted to Chas. Pfizer and Co., Inc., July 21, 1953, by the U. S. Patent Office.

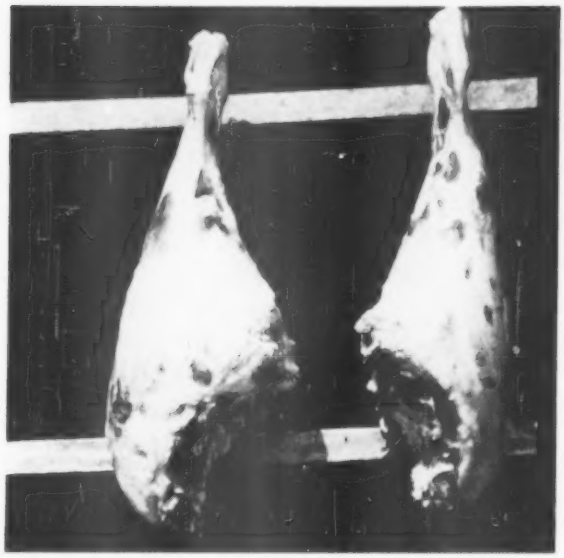

Figure 2. Paired rounds number 22 were kept after slaughter at room temperature 80-85° F. The swollen control is shown on the left and the sound infused round on the right.

TABLE 3

Comparison of moisture and total hemoglobin and myoglobin in infused and control paired rounds

Round number	% Moisture		% Hemogl. + Myogl.	
	Infused	Control	Infused	Control
9	78.3	76.6	0.30	0.38
10	77.9	75.0	0.31	0.39
11	80.1	75.0	0.36	0.41
12	78.9	74.4	0.60	0.87
13	78.7	75.3	0.52	0.60
14	79.0	77.5	0.53	0.58
15	78.8	74.6	0.57	0.63
16	78.3	74.5	0.53	0.57
17	78.6	76.7	0.62	0.77
Average	78.7	75.5	0.48	0.58

these rounds at room temperature for 48 hours. Consequently, no preservative effects were apparent from the mechanics of infusion.

INFUSION OF WHOLE ANIMALS

For this work 7 less expensive lower grade animals were used for reasons of economy; they ranged in weight from 700 to 1250 pounds.

The animal was stunned by a blow on the head in the usual manner and then shackled. The neck was opened along the mid-line exposing the carotid arteries. These were closed by hemostats and partially severed between the aorta and hemostat along with complete cutting of the jugular veins. The animal was hoisted momentarily to facilitate bleeding. Next the animal was placed on the pritch bed and one carotid artery was cannulated using a 10 mm. tube attached to the Griffith pump by rubber connection. The maximum output of the pump was less than the heart output of the animal. Even so it was possible to infuse the animal without excessive pressure as in the case of rounds and complete it in about 15 minutes. In all cases except number 7, 10% of the weight of the animal was the amount of aureomycin in saline which was infused. The infusate was the same as in the rounds except in number 7. The completeness of the infusion could be seen simply by opening the skin at the shank and at the mid-line above the sternum and also by observing the effluent from the severed veins.

After the infusion the animal was dressed in the usual manner. Although at dressing the skeletal muscle appeared normal, the viscera showed some altered appearances due to flushing out of the blood residues. Since the flow of the infusate was through the aorta to the tissues and back to the vena cava and out the jugular vein, the hearts appeared pale and at times the lungs were only slightly altered in appearance. In one or 2 instances the lungs were also flushed out. All animals were inspected for disease.

The carcasses were split in the usual manner and shrouded. One side was immediately chilled out in the customary manner whereas the other was allowed to stay at room temperature for 48 hours prior to chilling. The sides were studied for bacterial populations and aureomycin residues in different tissues and the meat was tested for tenderness (*3*), for moisture and total nitrogen.

Seven animals, one steer and 6 cows, were treated as described. One cow, number 5, had been used for a study on feeding excessive amounts of vitamin D by the College of Veterinary Medicine and we were assured that it would be a satisfactory meat animal for an experiment. However, it had an inelastic and calcified vascular system. Its arteries were quite small and the infusion was difficult. The usual amount of infusate was not used. Although this made a poor experiment it is included as the data are interesting in showing the effects of such pathology.

In Table 4 results of the bacterial examination of the infused beef are shown. In these data 0.3 is the minimum count detectible so that less than 300 organisms per g. were present. It was quite apparent that very few organisms were present even in the sides where refrigeration was delayed. The greatest numbers were present in the side held at room temperature for 48 hours. The counts in these decreased markedly when refrigerated. The implications of this finding are not clear. It might indicate increased effectiveness of the antibiotic at lower temperatures, or a bacteriocidal effect of the meat itself at these lower temperatures.

The warm side of animal 6 deserves a comment. After 48 hours at room temperature the side was rather odorous, but it was not a typical sour. The kidney was quite bad and warm to

TABLE 4

Bacteria in infused beef at various times post mortem and comparing refrigerated sides with sides held at room temperature 48 hours and then refrigerated

Animal number	Tissue	Thousands of bacteria per gram				
		At slaughter	48 hours		120 hours	
			R[c]	DR[d]	R[c]	DR[d]
1	Round	0.3	0.3	6	1.6	1.8
	Rib	1.4	0.3	13	1.7	3.2
	Chuck	1.8	0.3	12	1.7	2.8
	Nodes	—	—	—	0.8	1.8
2	Round	0.3	0.3	0.8	1.0	1.2
	Rib	0.3	0.3	2.7	1.5	2.0
	Chuck	0.3	0.3	2.0	1.0	1.8
	Nodes	—	—	—	0.3	0.3
3	Round	1.5	1.0	8.6	1.2	1.7
	Rib	2.5	1.8	15.	1.2	2.0
	Chuck	0.3	1.0	15.	3.0	4.0
	Nodes	—	—	—	1.1	1.0
4	Round	0.3	0.8	3.4	1.0	2.0
	Rib	0.3	0.3	30.	1.5	1.7
	Chuck	0.3	1.4	25.	1.7	3.0
	Nodes	—	—	—	0.8	2.0
5	Round	0.3	0.3	7.5	0.8	1.0
	Rib	0.3	0.3	12.	1.0	1.0
	Chuck	0.3	0.3	16.	0.8	1.0
	Nodes	—	—	—	1.0	1.6
6	Round	0.3	0.3	1.8	0.3	0.8
	Rib	0.3	0.3	13.	0.3	0.8
	Chuck	0.3	0.3	15.	1.0	1.0
	Nodes	—	—	—	1.5	2.1
7	Round	0.3	0.3	1.8	0.3	1.0
	Rib	0.3	0.3	6.0	0.3	0.8
	Chuck	0.3	0.3	7.5	0.3	1.8
	Nodes	—	—	—	0.3	1.0

[c] Refrigerated. [d] Refrigeration delayed.

the touch. The kidney was excised and examined. On examination it appeared to be infected with a pathogenic organism which seemed to be similar to *Proteus mirabilis* and *Proteus ammoniae* known to be pathogenic and cause cystitis. Whether the kidney of the refrigerated side would have gone bad cannot be said. In any event, neither kidney was examined by the inspector at slaughter. It can be seen that the meat from this animal was quite sound in spite of the infected kidney.

During the course of this work 5 organisms were isolated from 5 distinct cases of deep spoilage—4 in control rounds in addition to the one described above.

Control round number 10 yielded a *Bacillus* which was a gram positive spore forming rod. It was actively proteolytic to milk and gelatin and somewhat motile. Its optimum temperature was 25° C. It would grow aerobically and also anaerobically though at a diminished rate; it would produce acid and gas from arabinose, sucrose, glucose, maltose, dextrin, lactose and xylose but not from rhamnose. This organism appeared to be similar to *Bacillus megatherium* reported by Bunyea in 1921 *(2)*.

Control round number 15, which was odorous and off color, contained a facultative gram negative rod that gave biochemical reactions for *Escherichia* with the unusual characteristic of being capable of liquefying gelatin. Its optimum temperature was 37° C.

The control lymph node shown in Figure 1 was green and yielded only a *Streptococcus* which liquefied gelatined and peptonized litmus milk. The organism grew well at 10° C. and also at 45° C. showing some relation to *Streptococcus liquifaciens*.

From the round shown in Figure 2 an organism of the *Proteus* group was obtained. It differed from that isolated from the kidney described above in that it had an optimum temperature of 25° instead of 37° C. and produced indole.

In all 7 animals, as with the rounds, no flavor differences were noted which could be attributed to the infusion of the aureomycin. The infused beef did appear to be somewhat more moist to the touch. It was thought that this might be due to flushing out the coagulable blood and replacing it with a clear liquid. Also, the nitrogen-moisture ratio was slightly lower for the infused meat. In order to determine if these difficulties might be overcome the concentration of the antibiotic was increased threefold and the volume of infusate was decreased to one-third. This did prevent excessive moisture on the cut surface and still apparently sufficient antibiotic did get into the meat. Animal number 7 weighing 1233 pounds was infused with 40 pounds of physiological saline containing 3 grams of aureomycin.

No adverse color or paleness resulted from infusion of any animal. There was an unexpected color improvement, however, in the side which was kept at room temperature. It had not been expected and was observed in 3 cases—the last three.

The tenderness of the loin steaks from the refrigerated side was less than those from the other side. In fact, the steaks from the sides kept at room temperature for 48 hours and then chilled out were as tender at 5 days post mortem as the others were at 2 weeks post mortem. Table 5 shows the tenderness of loin steaks at 5 days post mortem.

The eating quality of the infused meat was quite satisfactory and from the taster's point of view indistinguishable from normal meat. All of the meat in this study was consumed by known persons. This amounted to about 5500 to 6000 pounds. No adverse report was received which in any way was attributable to infusion or to the antibiotic.

TABLE 5

Tenderness of loin steaks from infused beef at 5 days post mortem comparing immediate and delayed refrigeration

Animal number	Tenderness	
	IR	DR
1	6.33	7.17
2	5.00	5.33
3	2.33	6.33
4	7.25	8.42
5	5.66	7.50
6	1.33	5.25
7	5.58	7.25

AUREOMYCIN IN INFUSED BEEF

Although this study was undertaken to determine the possibility of processing whole animals by infusion before dressing out, the selection of an antibiotic for this work offerd an opportunity to study some of the important aspects of using an antibiotic (as aureomycin) in processing a perishable product of such importance as meat.

The aureomycin is certainly an additive and even if no obvious indications of altered product are apparent, there are the important questions of how much aureomycin was left in the meat and what happened to it.

To get some of these answers some experiments were carried out first by adding aureomycin to ground beef and determining the rate of its disappearance. Figure 3 shows the average aureomycin residue in 11 samples of ground beef stored at 10° C. when initially the beef contained 2 p.p.m. of the antibiotic. Almost no aureomycin was present after 3 days and none after 4 days.

It was of interest to know if aureomycin was as stable in beef as in physiological saline at the same pH and temperature. Figure 4 shows a graphic illustration of the results which seem

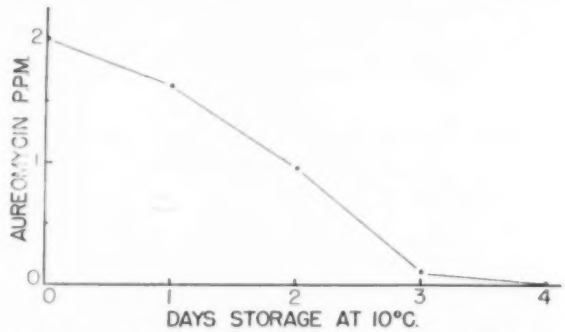

Figure 3. The average aureomycin content of 11 samples of ground beef stored at 10° C.

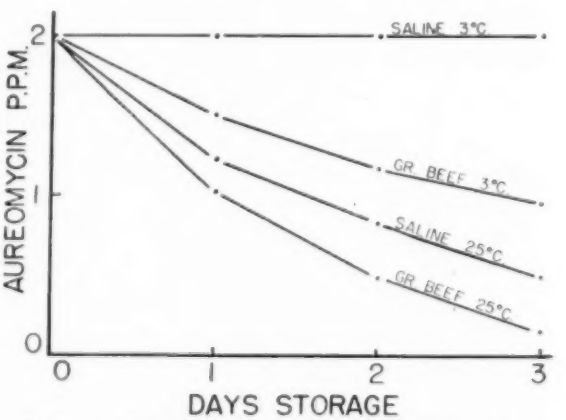

Figure 4. The disappearance of aureomycin from physiological saline and ground beef of the same pH at 3° C. and 25° C.

to show that the antibiotic is less stable in beef than in saline at 3° and at 25° C. This is what might be expected from the work of Dornbush *(4)*, Paine and Collins *(9)* and Price *et al. (10)*.

As expected the infused antibiotic was not evenly distributed throughout the carcass. One might expect that those tissues having the greatest blood supply would also have the highest antibiotic content. Furthermore, there is the question of what

happens to the aureomycin. This information for 10 rounds is shown in Figure 5.

On the average the top round contained about 5.0 p.p.m. whereas the shanks only 2.0 p.p.m. and the knuckles 0.5 p.p.m. It is recalled that the work on ground beef indicated at least 2.0 p.p.m. of antibiotic is desirable. Attention is called to the fact that at 4 days no aureomycin was detectible. Although there was some variation in amounts found in the rounds, the relative differences between top round and shank or knuckle was essentially the same in all cases. This reflects the blood supplies to these portions of the rounds.

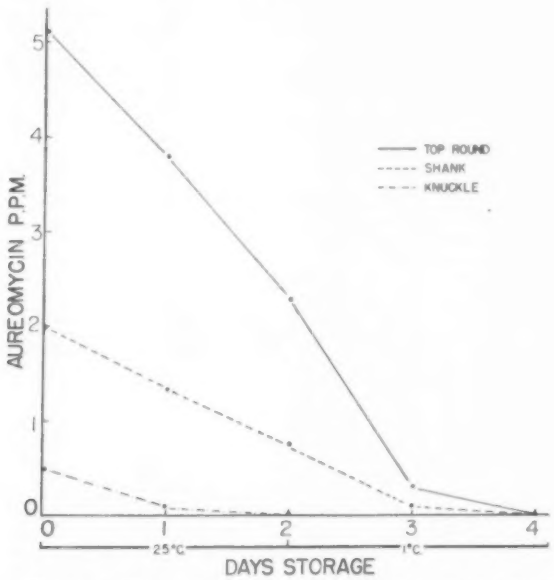

Figure 5. The average aureomycin residues from 10 infused rounds held after slaughter at room temperature 25° C. for 2 days and then at 1° C.

Figure 6 shows the same composite data on 6 whole animals. The upper 3 curves represent the disappearance of aureomycin in the chilled sides and the lower 3 represent this same thing in the sides held at room temperature for 48 hours prior to customary refrigeration. It appears that the infusion was uniform within sides. Whereas after 5 days in the chilled sides aureomycin was present in about 1.0 p.p.m., it was less than 1.0 at 3 days and was 0.0 at 5 days when chill was delayed.

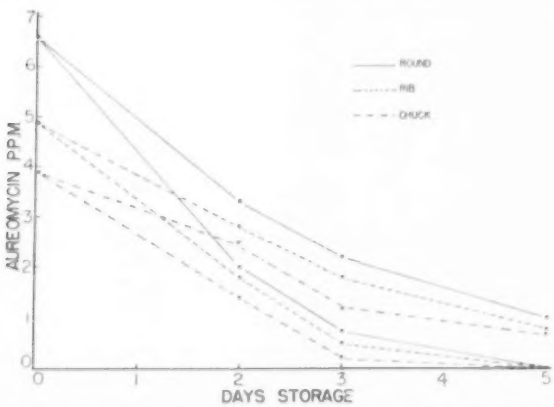

Figure 6. The average aureomycin residues in the carcasses of whole infused animals. The upper three curves represent the average aureomycin residues in the refrigerated sides and the lower three curves gives the same information for the sides where chilling was delayed 48 hours.

There is no doubt that the antibiotic disappeared as far as the test organism was concerned. What happened to it is not known. Whether its decomposition products are of importance from the public health standpoint is not clarified. It seems quite doubtful that the infusion of the aureomycin would be a public health hazard. To get a therapeutic dose would require the consumption of an enormous amount of meat, one animal per day. That the decomposition products appear to have no effects on the test organism indicates that they are relatively nontoxic.

Processing meat by infusion before dressing at slaughter present some problems of packing house operations. There is also the problem of meat inspection. Nothing was encountered in these studies to indicate that there are insurmountable problems. The procedures we used depart from those approved by the Bureau of Animal Industry. On the other hand it seems that inspection procedures could be adapted if later investigations should indicate the desirability of infusing whole carcasses.

SUMMARY

The possibility of processing fresh meat by infusion of whole animals before dressing out has been explored.

The infusion of aureomycin may prevent deep spoilage in carcasses where refrigeration is delayed. There are indications that deep spoilage may arise from organisms present in the lymph nodes.

Aureomycin is more rapidly destroyed by beef tissue than by water alone in a relatively short time.

Beef infused with aureomycin showed slightly altered appearance but from the standpoint of eating quality was indistinguishable from normal beef.

No adverse effect was noted when beef infused with aureomycin was consumed by known persons. Additional study is needed to determine the fate of the added antibiotic.

Processing of beef by infusion before dressing out shows some promise, but some modification of certain packing house and inspection procedures would be required.

Acknowledgment

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LITERATURE CITED

1. Bowen, W. J. The absorption spectra and the extinction coefficient of myoglobin. *J. Biol. Chem.*, **179**, 235 (1949).
2. Bunyea, Hubert. Souring in beef caused by *Bacillus megatherium*. *J. Agr. Research*, **21**, 689 (1921).
3. Deatherage, F. E., and Reiman, Walter. Measurements of beef tenderness and tenderization of beef by the Tenderay process. *Food Research*, **11**, 525 (1946).
4. Dornbush, A. C. (Private communication, 1952.)
5. Goldberg, H. S., Weiser, H. H., and Deatherage, F. E. Studies on meat IV. The use of antibiotics in the preservation of fresh beef. *Food Technol.*, **7**, 165 (1953).
6. Husaini, S. A. Biochemical studies relating to quality in fresh meat. (Ph.D. dissertation, The Ohio State University, 1950.)
7. Husaini, S. A., Deatherage, F. E., and Kunkle, L. E. Studies in Meat II. Observations on relation of biochemical factors to changes in tenderness. *Food Technol.*, **4**, 366 (1950).
8. Lepovetsky, B. C., Weiser, H. H., and Deatherage, F. E. A microbiological study of lymph nodes, bone marrow and muscle tissue obtained from slaughtered cattle. *Applied Microbiology*, **1**, 57 (1953).
9. Paine, T. F., and Collins, H. S. Laboratory studies with aureomycin. *N. Y. Acad. Sci.*, **51**, 228 (1948).
10. Price, C. W., Randall, W. A., and Welch, H. Bacteriological studies of aureomycin. *N. Y. Acad. Sci.*, **51**, 211 (1948).

The Variation in Tenderness in the Longissimus Dorsi Muscle of Pork[a]

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Analysis of tenderness data obtained by organoleptic and mechanical shearing tests, showed that the longissimus dorsi muscle of hogs was less tender in its central portion than at either extreme. Tenderness differences between certain positions within the loin are highly significant. Care should be taken, in studies concerning the effect of experimental treatments on tenderness in pork loins, that all sections of the longissimus dorsi muscle are represented in each treatment.

Studies of tenderness problems in meat have been made primarily on beef and several investigations on tenderness variations between and within beef muscles have been reported. Ramsbottom, Strandine and Koonz *(1)*, reported in 1945 that there was no difference in tenderness, measured by resistance to shearing, between the middle and posterior end of the *longissimus dorsi* muscles taken from 3 heifer carcasses. The anterior end, however, was markedly tougher than the rest of the muscle. Blakeslee and Miller *(1)* observed that the beef shortloins were less tender at the rib end than at the porterhouse steak end. These latter results were substantiated by those of Hiner and Hankins *(3)* who found highly significant tenderness differences in favor of the loin end between the loin end and shortloin sections of the longissimus dorsi muscle of aged cows. Contrary to the findings of Ramsbottom, Strandine and Koonz *(1)*, Hiner and Hankins observed no significant difference in tenderness between the loin end and rib sections of the loin muscle, but found a significant difference in favor of the anterior part of the muscle when samples from the shortloin and chuck (3rd rib) were compared.

The only report available on tenderness in the pork *longissimus dorsi* muscle was that of Bray, Vail, and Mackintosh *(2)*. They found no difference in tenderness measured by mechanical shearing tests from the anterior to the posterior of the loin muscles of 250 pound hogs. The disagreement in the published data on tenderness variations in beef loins in addition to the lack of data on the subject wherein organoleptic tests for tenderness had been used, prompted further investigation on the uniformity of tenderness in the pork longissimus dorsi muscle.

EXPERIMENTAL

The *longissimus dorsi* muscles used were from both the right and left sides of 6 hogs slaughtered under uniform conditions at Beltsville. The hogs had a mean slaughter weight of 213 pounds. The pork carcasses were chilled at 0.6° to 1.7° C. (33° to 35° F.). The loins were removed and each loin was cut into 8 approximately equal parts. The 8 samples from each side were cooked and tested at a single testing period. The pork loin samples were cooked in a constant temperature, forced air circulation oven maintained at 148.9° C. (300° F.) until the internal temperature of the loin muscle reached 76.7° C. (170° F.). The *longissimus dorsi* muscle was separated from the ribs and vertebrae and, a sample, one inch in diameter, was cut longitudinally through the muscle for mechanical shearing tests using the Warner-Bratzler shear strength apparatus. The remainder of the muscle was cut into pieces one-half inch square and one-eighth inch thick for tenderness rating by a judging panel composed of 8 persons experienced in meat judging. The same judges served throughout the experiment.

Tenderness scores ranged from 1 for tough samples to 5 for very tender samples. The judges' scores for each sample were totaled and the data were analyzed by the analysis of variance method described by Snedecor *(5)*. The variation due to sample location in the muscle was further analyzed on the basis of individual comparisons.

RESULTS

When the mean organoleptic and shear force values for all the samples tested at each location in the muscle, were recorded graphically (Figure 1) it was apparent that the anterior and

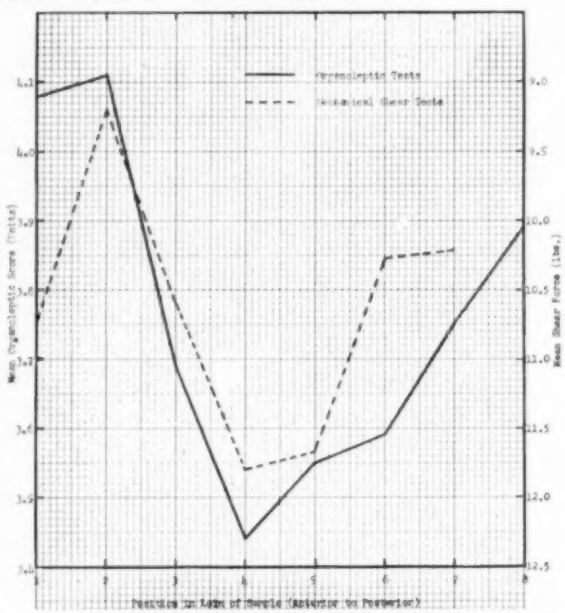

Figure 1. Tenderness variation within pork longissimus dorsi muscle.

posterior portions of the muscle were more tender than the central portion of the loin which corresponds to the shortloin of beef. Inspection of the sums of the organoleptic scores and resistance to shearing values for individual segments of the pork loin (Table 1) sugggested that this tenderness difference between areas in the muscle was large enough to be of statistical significance should direct comparison within individual loins be attempted. The analysis of variance for the total scores for tenderness on individual samples is given in Table *2* for both the organoleptic and shear force methods. Variations in tenderness between animals are shown to be significant by the organoleptic test and highly significant by the resistance to shearing method. Organoleptic tests showed little variation between right and left sides but the shearing data showed a highly significant variance. No explanation for this discrepancy can be given.

[a] Presented before the Thirteenth Annual Meeting of the IFT, Boston, Massachusetts, June 22, 1953.

TABLE 1

Summary of organoleptic and resistance to shearing values obtained for consecutive sections of pork loins

Sample location (anterior to posterior)	Organoleptic scores[b]		Resistance to shearing[c] (lbs.)	
	Right side	Left side	Right side	Left side
1	211	178	143	226
2	200	198	150	182
3	182	174	173	209
4	167	161	192	234
5	163	180	198	222
6	164	181	174	196
7	180	181	177	191
8	190	188	—	—

[b] The organoleptic scores represent the sum of individual judgments by 8 judges on pork loin sections from 6 hogs.

[c] Resistance to shearing values represent the sum of 9 shearing tests on pork loin sections from 6 hogs.

When the total data were analyzed, variation in tenderness due to position within the loin was not significant statistically; however, when the various positions were compared individually among themselves (Tables 3 and 4) it was evident that statistically significant differences in tenderness existed between certain positions within the loins. There were no tenderness differences noted by the tasting panel between the *2* anterior positions tested including the second through the eighth rib areas. These sections were much more tender (highly significant) than the remainder of the loin except for the extreme posterior portion. The fourth section of the loin which was composed of the muscle from the last of the rib region was considerably less tender than the rest of the loin except for the adjoining sample number 5 which comprised the anterior part of the lumbar vertebrae region of the muscle. The posterior portion of the muscle, sample 8 from the sacral region, was similar in tenderness to sample 1, although it was significantly less tender than sample *2* and more tender than sample *3*. Immediately adjoining samples did not show large enough differences in tenderness scores to be significant statistically, except for samples *2* and *3* and samples *3* and 4 where succeeding samples became progressively less tender, the differences being highly significant and significant respectively.

The differences in shear values (Table 4) within the loin followed the same pattern but did not show as great differences as the organoleptic scores. The shear values for the central portion of the loin muscle (samples 4 and 5) were significantly higher, reflecting lesser tenderness, than those for the anterior portion (samples 1 and *2*).

TABLE 4

Analysis of variance, single degrees of freedom, of shear force values for tenderness between consecutive sections of pork loin

Sample location (anterior to posterior)	"F" values					
	Sample location (anterior to posterior)					
	2	3	4	5	6	7
1	0.12	2.02	5.56*	7.02*	2.13	2.64
2	—	1.15	5.56*	5.28*	1.23	1.62
3			0.88	1.50	0.00	0.04
4				0.08	0.81	0.54
5					1.41	1.05
6					—	0.03

*Denotes significance at the 5% level.

SUMMARY

Organoleptic and mechanical shear tests for tenderness were made on the cooked longissimus dorsi muscles from the right and left sides of 6 hog carcasses. Both methods of tenderness determination showed the anterior and posterior parts of the loin muscle to be more tender than the middle. Differences between locations were not statistically significant when analyzed in relation to the data as a whole, but when the various locations were compared individually, highly significant differences were found between certain locations.

LITERATURE CITED

1. Blakeslee, L. H., and Miller, J. I. Shear Tenderness Tests on Beef Shortloins. *J. Animal Sci.*, **7**, 517 (1948).
2. Bray, R. W., Vail, G. E., and Mackintosh, D. L. Influence of Freezing Upon Tenderness in Aged Beef. *J. Animal Sci.*, **1**, 81 (1942).
3. Hiner, R. L., and Hankins, O. G. The Tenderness of Beef in Relation to Different Muscles and Age in the Animal. *J. Animal Sci.*, **9**, 347 (1950).
4. Ramsbottom, J. M., Strandine, E. J., and Koonz, C. H. Comparative Tenderness of Representative Beef Muscles. *Food Research*, **10**, 497 (1945).
5. Snedecor, G. W. *Statistical Methods*. 4th ed., 1946, Iowa State College Press, Ames, Iowa.

TABLE 2

Analysis of variance in tenderness of pork loins as measured by organoleptic tests and resistance to shearing

Sources of variation	Organoleptic tests			Resistance to shearing		
	Degrees of freedom	Mean squares	"F" value	Degrees of freedom	Mean squares	"F" value
Total	95	29.72		83	132.51	
Animals	5	97.43	6.01*	5	1157.01	14.74**
Sides	1	2.32	0.01	1	760.21	12.79**
Positions	7	19.64	1.52	6	88.16	1.21
Animals x Sides	5	41.52	4.37**	5	79.45	2.58*
Animals x Positions	35	12.52	1.32	30	78.32	2.55**
Sides x Positions	7	21.65	2.28	6	42.71	1.39
Animals x Sides x Positions	35	9.50		30	30.69	

*Denotes significance at the 5% level.
**Denotes significance at the 1% level.

TABLE 3

Analysis of variance, single degrees of freedom, of organoleptic ratings for tenderness between consecutive sections of pork loin

Sample location (anterior to posterior)	"F" values						
	Sample location (anterior to posterior)						
	2	3	4	5	6	7	8
1	0.13	13.12**	39.95**	26.04**	22.29**	9.68**	0.15
2		22.71**	55.26**	39.00**	34.39**	17.28**	5.56*
3			7.28*	2.19	1.21	0.37	5.78*
4				1.48	2.56	10.94**	26.03**
5					0.14	4.36*	15.09**
6						2.92	12.27**
7							3.22

*Denotes significance at the 5% level.
**Denotes significance at the 1% level.

Economic Adjustments That Have a Special Bearing Upon Food Supplies and Public Health[a]

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There is a close relation between expectation of life at birth and efficiency of food use. In a country like India with an expectation of life at birth now of only 30 years, all of the food consumed in bringing children into the world and rearing them to a working age has to be charged to about 15 working years. With an expectation of 45 years, it is spread over 30 years. The efficiency of food use, other things being the same, increases as the average life span increases, until a point is reached where the numbers of non-working persons over 60 or 65 years of age who consume food without working for it begins to reduce the efficiency of food use. No adequate data are available as to how much work is done by elderly and retired persons, but there is little doubt, so far as this factor alone is concerned, that the efficiency of food use is less in New Zealand, for example, than in some countries with a somewhat shorter life span.

Dr. Charles Davidson, of course, in his paper "Guiding Principles for the Solution of Dietary Problems of an Aging Population,"[b] suggests meeting this situation by keeping the elderly persons healthy and at work and paying for their own keep. However, when this was suggested at a meeting of the American Population Association a few years ago it was attacked vigorously. Why should we be shortening the work week to 5 days, and presently perhaps to 4, for persons in their prime, and increasing the work load of those over 60? What do we work for, if not to live at ease in our older years?

Closely related to the foregoing is the relation between how hard we work and how long we live. That the productive years of cows and hens are shortened by increasing the output is a familiar fact. How is it with humans? There appears to have been very little analysis of this problem. Is it not an important aspect of the subject? With cows and hens, it pays, up to a certain point, to speed up output and shorten lives—a smaller fraction of the feed goes into maintenance.

This raises the whole question of the relation between maintenance and production rations as a factor in efficiency of food use. In a country in which the average caloric intake per worker per day is 3000, of which 1800 is for maintenance, the 3000 calories produces twice as much work output as that of the average worker in a country with an average caloric intake of 2400. This is another reason why the efficiency of food use is low in countries like India. Dr. Davidson in discussing the diets of the aged did not refer to the effect of inactivity in reducing caloric intake.

[a] Presented before the Thirteenth Annual Meeting of the IFT, Boston, Massachusetts, June 22, 1953.

[b] Presented at the same session, July 22, Thirteenth Annual Meeting of IFT, Boston.

POPULATION AND FOOD SUPPLY BALANCE

Turning now to the first of the broad aspects of the food problem, mentioned by Dr. Compton,[c] namely the population and food-supply balance—Norris Dodd, head of World Food and Agriculture Organization, a few years ago was warning the world that each day it had 57,000 new mouths to feed. In his most recent statement, he has raised the figure to 70,000. Apparently he has been doing some more arithmetic. It is true that the bigger the total with a given annual growth rate, the larger the absolute gain per year and per day.

What does this growth of population mean for the people of the United States? Possibly a good deal in terms of world politics and national security. It can be that in the future the high death rates and suffering of the people of the Far East and other parts of the world will so lead to unrest and revolution as to destroy the peace of nations. However, in the long run of centuries since the dawn of civilization, widespread death from disease and underfeeding probably has rarely been a major cause of wars and revolutions. Death and disease have been so familiar to nearly all in most parts of the earth in the past that they have been accepted as normal experience. But modern communication has revealed to the present generations of peoples of these old civilizations that in other parts of the earth not only are most children kept alive and healthy, and many elderly folks living to a ripe old age, but that they are at the same time enjoying many comforts and delights. And the underfed peoples are turning against their overlords and blaming them for their sufferings. And they listen to false doctrines told to them by national leaders who at the best simply do not understand, and at the worst are only political schemers. Out of this situation does arise a serious menace to our part of the society of nations.

Yet in spite of this menace, this country of ours, and others like it with bountiful food supplies, are not likely to be shipping large quantities of food to the over-populated countries to keep down their death rates. To be sure, when a famine threatens because of a disaster, as now in Pakistan, we shall come to the rescue, especially if we have large surpluses in government hands and can find no other easy outlet for them. But this is very different from exporting large quantities of food regularly to underfed nations. This we and other nations like us will not do except as the underfed nations can find export goods with which to pay for the foods they need. They can sell us a little more of tea, coffee, rubber, bananas, and some other fruits, and of certain vegetable oils, and perhaps some day increasing amounts of certain types of manufactured goods, especially the types that require much hand labor. But even if this country were ready to accept a liberal foreign-trade policy, its imports from these countries would increase slowly. This statement also fits the other large food-exporting nations.

What this country is doing instead is helping these countries to produce more food themselves and to industrialize—hoping that out of this combination will presently come more food per person. There will be a real danger, however, that in part of the countries, especially in the first 50 years, death rates will fall so much faster than birth rates that all the gains from improved technology in agriculture and industry will be swallowed up in growth of population. Nevertheless, this is the only kind of a program that has a chance of being importantly effective in relieving the pressure of food supply in these countries.

How does this leave the food supply situation in the United States and countries like it? The answer is—an ever-present

[c] Reference is made to the address of Dr. Karl T. Compton, "In the Public Interest," Thirteenth Annual Meeting of the IFT, Boston, June 22.

potential surplus situation. The evidence to this effect for the United States—and roughly parallel evidence could be assembled for most of the rest of North America, for considerable parts of South America, Africa, and for the South Pacific—is contained in the report of the President's Materials Policy Commission of 1952 (hereafter referred to as the PMPC report) which balances prospective population growth and income growth against output for the year 1975. The population growth projected by then is 193 millions. The disposable income, that is, income after taxes, even if it rises no faster than in the 1925-50 period, will rise from $1300 to $2000 per capita.

How much of this rise in per capita income will be spent on more food? If one were to take the recent historical past as a guide, one would project at least as large a percentage in 1975 as in 1950, since this percentage was 24 in 1920 and 26 in 1950. It fell off only to 22 during the war years. But included in actual food expenditures at retail are all the costs and profits of food processing and distribution—the ones in which food technologists are particularly interested. There was a large increase between 1929 and 1950 in preparation of foods for use in the kitchen and on the table—in canning, quick-freezing, and pre-packaging,—in some of the services sold with foods—principally the supermarket type of services'—and in meals eaten outside the home. The nearest that one can come to measuring increase in consumption of food as food is to take the U.S.D.A.'s index of per-capita food consumption. This rose from about 100 in 1929, and also 100 in 1935-39, to 114 in 1945; it rose to 117 with derationing in 1946, and then fell off to 112 with the rising prices of meats in 1950. This rise from 100 to 112 was of course not due to higher caloric intake; it reflected only a higher fraction of the calories coming from meats and other more expensive foods.

PROJECTING FOOD CONSUMPTION AND PRODUCTION INTO THE FUTURE

A projection of this 112 in 1950 forward to 1975 is of course very difficult. The analysts in the Bureau of Agricultural Economics (hereafter referred to as BAE) have arrived at figures ranging from 118 to 122. The PMPC projection is 127. This is based upon an analysis made by Dr. Marguerite Burke of the BAE to the effect that for every increase of 1% in disposable income in the past, there has been an increase of 0.2% in the index of per-capita food consumption, assuming 115 as what the 1950 index would have been except for the abnormally high price of meats in 1950. If 112 had been taken as the base instead of 115, the projection for 1975 would have been 124 in place of 127. Either of these rises in per-capita consumption combined with a 27% rise in population—to 193 million by 1975—will call for a 41% rise in national food consumption, *and also in domestic food supply*, assuming no change in the balance of food exports-imports. The PMPC report concludes that imports will increase slightly more than food exports, since consumption of coffee, tea and tropical fruits will grow with the population.

How this 41% increase in food consumption is distributed among different classes of food is of much importance to the food industry. The PMPC report divides it as follows:

Food Classes or Items	Percentages
All meats except poultry	50
Poultry meat	66
Eggs	38
Milk, fluid, condensed, dried	44
Butter	15
Fats and oils, including butter	34
All fruits	54
Vegetables—fresh	48
Vgetables—processed	63
Potatoes	9
Sugar	25
Wheat products	23

The significance of each of these is best judged by comparing it with the average of 41%. A percentage less than 27 means a per capita decline. None of these percentages is to be taken as highly conclusive. They are mostly forward projections from trends since 1935-39. Butter consumption has already declined more per capita than projected in the preceding tabulation. A simple projection for egg consumption would have given a higher figure than 38%.

Now as to the projection of output. The PMPC staff and consultants explored this carefully, taking advantage of the counsel and judgments of the scientists in the U.S.D.A., the agricultural colleges, and the experiment stations. Two estimates were made—an A estimate, or potential increase if present known or "almost known" technology were generally applied between now and 1975, and a B estimate, or increase if such technology is applied at the average rate of the past 25 years. Both are in the form of increased yields per acre or per head of livestock, with about the same amount of crop and pasture land as now farmed. Following are the summaries of these estimates and a few of the individual crop and livestock estimates:

	A estimate	B estimate
All food crops	56	27
Wheat	50	20
Potatoes	100	40
Feed crops	85	34
Corn	100	40
Oats	70	25
Soybeans	50	20
Forage (including pasture)	62	31
Feed and forage combined	75	33
Livestock products per head	48	24
Livestock and products, including feed and forage	103	36
All foods	90	34

The A estimates for foods give a potential of 90, which is well beyond the 41% increase in consumption projected. If non-foods are included, the potential is still 86%. The B estimates, however, indicate that not enough food will be produced from present acres unless technological advance is faster than from 1925 to 1950. The 34% becomes 33% if non-foods are added.

An alternative to increasing yields on present acres is of course to use more acres. Are such acres available? Numerous statements have been made in the past year by officials in the U.S.D.A., including one Secretary of Agriculture, that now that the Western frontier of new land has come to an end, any increase in farm output must come from acres now in crops and pasture. This is grossly contrary to the facts. A classification of the lands of the United States recently completed by the Soil Conservation Service indicates that there are 150 million acres of grassland that could be converted to cropland, and 135 million acres of woodland that could be converted to cropland or grassland. (Set over against this are only 40 million acres now in crops that should be shifted to grassland or woodland.)

The principal reason that these 285 millions of acres have not been used for crop and grassland is that it has been cheaper to get the additional product needed from stepping up yields on lands now in crop or pasture. The same can be true between now and 1975. But this is very different from saying that all the increase in output must come from present acres in crops or grass. The chances are that a minor fraction of the increased food needed by 1975 will come from bringing additional land into crop use, plus converting perhaps 80 million acres of poor open pasture and 10 million acres of woodland pasture, into crop and pasture rotations, but with little if any more than now in cultivated crops in any year. The new technologies of grassland farming have a major contribution to make to the needed 41% increase in food supply, especially since a large part of the increase is to come from grass-and-forage-consuming livestock.

It is also necessary to make very clear that technological advance, in agriculture or elsewhere, never comes only from applying more fully the technology already known. Along with this are always new technologies being discovered and coming into use. If this were not so, our agriculture would not have made the progress which it did from 1925 to 1950. We need therefore to provide strong support continuously for the research that furnishes a basis for new technology.

FOOD CONSUMPTION AND INCOME

Now let us return to the consumption side of the food situation. It was pointed out earlier that the percentage

of disposable income spent for food was *26%* in 1950 as compared with *24%* in 1929. In the same years, the percentage of the consumers' dollars received by processors, transporters and middlemen fell from 58 to 53. In the current situation it is 56. It is pretty sure to rise as prices of farm products decline as they have been doing in the past year. With prices no higher than 90% of parity, which is as high as they can be expected to be in the next few years, the 58% level will be attained again. But whether it will persist is another question. The comparable level for 1913-15, in the parity-base years, was 54%.

There is reason to doubt also that the *26%* level for percentage of disposable income will be maintained. Probably it was a special set of circumstances that caused the percentage to rise to *26* in 1950—such as having the great mass of working population with incomes for the first time at a level that made it possible for them to buy about all the meat, eggs, dairy and poultry products that they had been wanting. It is of course an accepted economic principle that higher-income groups spend a smaller fraction of their incomes on food and more on education, health, travel and recreation, than do the lower-income groups. If this principle still holds, a further rise in the earnings of the great mass of our people will find them spending a larger share of their earnings, relatively, on these other parts of living and less, relatively, on food.

A rise of the index of food consumption per capita only from 112 to 127, or 13%, by 1975 will not of course support either a 58% level of marketing share of consumers' dollars or a *26%* level of spendable income spent for food with per capita spendable incomes rising from $1300 to $2000, or 54%. There will need to be an accompanying rise in the processing and services sold with the food, and this will have to be of relatively greater magnitude than the shift to the more expensive protective foods. A reasoned judgment is that the masses of the people will not want to increase their food bills as much as will be required to maintain the 58% or *26%* levels, and that levels around 54% and *22* or *23%* will be as high as will evolve. But this can be little more than judgment. We do not know enough about actual food consumption behavior to be sure that the index of food consumption will not rise appreciably more or less than the 15 points from 112 to 127. A little light on this subject may be thrown by the records kept of their meat consumption by a sample of 170 families in Medford, Massachusetts, during the past 8 months, under a research project conducted by Dr. Ayres Brinser and assistants of Harvard University, using Research and Marketing Act funds. It could well be that only part of working-class families will buy appreciably more meat and other expensive types of foods as their incomes increase another 54% by 1975. In this case, an assumption of no more than *22* or *23%* of disposable income spent on food in 1975 may be even too much to expect. If the study indicates clearly that meat purchase fell off at the high retail prices that prevailed in the fall of 1952 and recovered when retail prices fell in the first half of 1953, this will lend support to the foregoing judgment. Press reports now indicate that the national average of meat consumption was clearly higher in the first half of 1953 than in the same months in 1952.

WHERE THE FOOD TECHNOLOGIST COMES IN

There is another type of change and adjustment within the food industries that also must be taken account of; namely, the more complete utilization of some raw materials as foods. The use of skim milk and whey as human rather than animal foods is a striking example of this. The conversion of cull citrus fruit to juices is another. Of the same general effect is the substitution of more economical vegetable oils for animal fats and oils. It is in this sphere of action that food technologists make one of their largest contributions.

Such changes may force some difficult readjustments. The lessening of the demand for butterfat and other animal fats lowers their prices. It is not likely to increase the demand for the skim milk and whey enough to offset the decline in butterfat prices. There may well be a role for government to play in facilitating the needed adjustments, but surely this role should not consist of holding up the price of butter and pricing it out of the market on the one hand and subsidizing continued production on the other. Much more rational would be expanding the market for milk powder by subsidizing its use in bread and other foods. This would at the same time improve all these foods nutritionally by increasing their content of the particular proteins that have been proven to be most essential for body building and maintenance. Recent estimates are to the effect that a third of the children growing up even in this rich country do not get enough good animal-origin protein to grow as rapidly as they should, nor to obtain adequate protection against disease. (See Flodin, *Agr. Food Chem.*, April 26, 1953.)

FOOD SURPLUS CONSIDERATIONS

Surely this paper should not close without some reference to the current food surplus situation in the United States. The government is likely to find itself, under the existing price-support and CCC holding operations, committing itself to 2 billion dollars of expenditures, and in another year to 4 or 5 billion dollars. The acreage and marketing quotas for basic crops cover less than a third of total farm output, and it is recognized that these devices will not work with livestock products. There really is no solution to this problem except to convert a large acreage of land from growing foods of direct human consumption to foods of animal origin, which require, on the average, 7 times as much land per million calories to produce. But these will also require an increase in the rate of consumption of foods of animal origin. The most rational procedure is for the government, and the cooperating food trade, to do all they can to promote the latter. Propaganda will help, but far more important will be reducing the cost of these foods to the low-income third of the population. It is they only who will step up their consumption importantly as the cost of them is reduced. The short-run effect of such measure will be important, but the longer ones of having these families learn how to use these foods, and forming the habit of using them, will be more important in the end.

Rates of Freezing and Thawing Meats[a,b,c]

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The effectiveness of air blast, plate, and still air freezing at ranges from +2° F. (−17° C.) to −80° F. (−62° C.) as well as subsequent thawing at 40° F. (4° C.), 70° F. (21° C.), and 90° F. (32° C.) were investigated. Samples included beef and pork, fat and lean meat, wrapped and unwrapped, whole pieces and ground meat, six-inch cubes and six-by-six-by-three-inch samples.

Freezing as a method for preserving meat has been used since the early 1900's. About 1915 a temperature of +15° F. (9° C.) was considered adequate, but later with the advent of more efficient freezers, such as the Birdseye multiplate freezer, the use of brine submergence, fog type of freezing, and continuous belt freezers, temperatures of −10° F. (−23° C.) were considered necessary. More recently, there has been a great deal of interest in the possibility of using even lower temperatures to advantage. With the trend to lower and lower freezing temperatures, it seemed of practical interest to compare freezing rates at moderately high temperatures against very low.

Research has shown that freezing rates of meat are functions of ambient temperatures, types of freezing, wrapping materials, composition and size of sample *(1, 2, 8)*. The present study has thrown further light on these factors.

EXPERIMENTAL PROCEDURE

A 6-inch cube was prepared from rigid $^3/_{16}$-in. mesh galvanized wire screening. The meat for testing was placed into this cube. A filled cube of lean pork or beef (3-5% fat) weighed 3860 g., or 8.5 pounds. Similarly, a 6-inch cube of ground fat pork (39% fat) weighed 3650 g., or 8.05 pounds, and when the cube was filled with lard it contained 3300 g., or 7.25 pounds.

Temperatures of the samples were taken with thermocouples inserted 3 inches into the meat at points 0.5, 1, 2, and 3 in. from the bottom face, and equidistant from the sides. Thus the thermocouple 3 inches from the bottom was at the exact center of the 6-inch cube. For smaller samples, 6 x 6 x 3 in., the thermocouples were inserted in similar manner at points 0.5, 1, and 1.5 in. from the bottom.

When the effects of wrapping materials on freezing rates were tested, a layer of the material was formed into a 6 x 6 x 3 in. rectangle, which was placed into the 6 x 6 x 6 in. wire screen so that a single layer of material covered all 6 faces. The meat samples were placed in the package and carefully compressed to remove any air pockets.

Samples were frozen at ambient temperatures ranging from 2° F. (−17° C.) to −80° F. (−62° C.) in the air blast, in still air, and by plate freezing on vacuum plates refrigerated with Freon 22. Temperatures were recorded on strip charts with two 16-point automatic recording potentiometers, having a complete cycle in 1.5 minutes. Air blast at +2° F. (−17° C.) was 1500 feet per minute, and at −68° F. (−56° C.) was 1000 feet per minute.

Beef aged 10 days and pork 7 days after slaughtering were used.

During thawing at 40° F. (4° C.), 70° F. (21° C.), and 90° F. (32° C.), the relative humidities were respectively 90%, 75%, and 55%.

RESULTS AND DISCUSSION

Effect of wrapping on freezing rates. Ramsbottom, Goeser, and Strandine *(7)* showed that cellophane wrapping of meat increased the time required to freeze meat materially. Figure 1 shows the results obtained

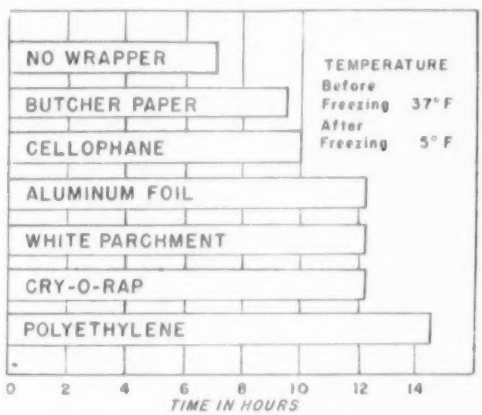

Figure 1. Effect of wrappers on freezing rate; 6 x 6 x 3-inch lean beef samples frozen at 2° F. air blast.

by wrapping 6 x 6 x 3 in. samples of ground lean pork in various types of packaging materials. The time required to freeze the unwrapped sample from 37° F. (3° C.) to 10° F. (−12° C.) in air blast at 2° F. (−17° C.) was 7.1 hours. Wrapping in butcher paper increased this time by 34%, cellophane by 41%, aluminum foil and parchment paper by 72%, Cry-o-rap by 76%, and polyethylene by 103%. Apparently freezing rates vary proportionately with respect to insulating properties of the wrapping materials.

Factors affecting freezing rates. Table 1 is concerned with the effect of various factors on freezing rates. Solid pieces of lean beef froze at the same rate as did ground beef of the same composition; lean beef and lean pork froze at the same rate; fat meat froze faster than did lean meat. Six by six by three inch samples of meat required 53% as long to freeze to the same temperature as did 6 x 6 x 6 in. samples having the same general composition and density. These results agree quite well with those of Ramsbottom *et al. (7)*.

Rate of freezing in relation to types of freezing. Table 2 shows the effectiveness of blast, still air, and

[a] Report of a study made under the Research and Marketing Act of 1946.

[b] Presented at the Thirteenth Annual Meeting of the IFT, Boston, Massachusetts, June 22, 1953.

[c] N. Bollinger assisted in the preparation of the samples for freezing and thawing, and in assembling the data.

plate freezing at +2° F. (—17° C.) and at —68° F. (—56° C.). Meat in +2° F. (—17° C.) ambient temperature in air blast required 12.2 hours to freeze to +10° F. (—12° C.), whereas similar samples required 32% longer with plate freezing, and 58% longer in still air. At —68° F. (—56° C.) ambient temperature, blast freezing took 2 hours, plate freezing 80% longer, and still air freezing 115% longer. Blast freezing at —68° F. (—56° C.) was more than 6 times faster than at +2° F. (—17° C.); plate freezing and still air freezing were 4.5 times faster. At —68° F. (—56° C.) ambient temperature a 6-inch cube of meat required 3.2 hours to freeze to —50° F. (—46° C.) in air blast, but took 90% longer with plate freezing and 110% longer in still air. It seems that blast freezing becomes more effective at very low air temperatures.

TABLE 1
Factors affecting freezing rates

	Fat	Hours[a]	Hours[b]
(6 x 6 x 6-inch samples)	%		
1. Solid Lean Beef	6	12.2	
2. Ground Lean Beef	4	12.0	
3. Ground Lean Pork	5		17.0
4. Ground Fat Pork	39		14.8
5. Lard	99+		13.0
(6 x 6 x 3-inch samples)			
6. Ground Lean Beef	4	6.6	
7. Ground Lean Pork	5	6.4	

[a] Time required in air blast and
[b] in still air at ambient temperature of 2° F. (—17° C.) to reduce temperature from 37° F. (3° C.) to 10° F. (—12° C.).

TABLE 2
Rate of freezing in relation to types of freezing and temperature of freezing

Types of freezing	Ambient temperatures	Hours[a]	Hours[b]
Blast	2° F. (—17° C.)	12.2	
Plate	2° F. (—17° C.)	16.1	
Still Air	2° F. (—17° C.)	19.3	
Blast	—68° F. (—56° C.)	2.0	3.2
Plate	—68° F. (—56° C.)	3.6	6.1
Still Air	—68° F. (—56° C.)	4.3	6.8

[a] Time required to reduce temperature in a six-inch lean meat cube from 37° F. (3° C.) to 10° F. (—12° C.), and
[b] From 37° F. (3° C.) to —50° F. (—46° C.).

Freezing curves. Figures 2 through 6 show typical freezing curves, and freezing patterns for 6-inch cubes of ground meat, at ambient temperatures ranging from 2° F. (—17° C.) to —80° F. (—62° C.).

The freezing curves shown in Figure 2 were for samples of ground lean beef. Temperatures were taken at the center of the samples. The sample frozen in air blast required only 21 minutes to pass through the zone of maximum ice crystal formation *(8)*, 31° F. (—1° C.) to 24° F. (—4° C.), plate and still air freezing took 1.2 hours to pass through this temperature range. Moran *(4)* considered a product "quick frozen" if it required 30 minutes or less to reduce its temperature from 41° F. (5° C.) to 23° F. (—5° C.). By this definition, none of the samples was "quick frozen." Poole *(6)* used the range 31° F. (—1° C.) to 24° F. (—4° C.) in 25 minutes, by which definition the air blast sample was "quick frozen." Plate freezing was somewhat quicker than still air freezing, but only half as fast as air blast.

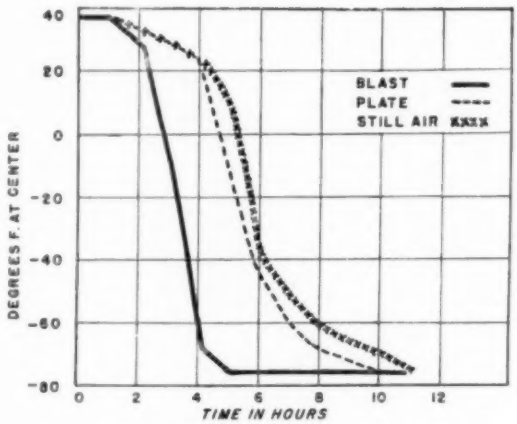

Figure 2. Freezing 6-inch meat cubes at —80° F.

The rate of freezing in blast, by plate freezing and in still air at —70° F. (—57° C.) and at 0.5 in. depth in a 6-inch cube of fat ground pork can be seen from the freezing curves in Figure 3. From 40° F. (4° C.) to —3° F. (—20° C.), the sample in the plate freezer dropped fastest in temperature; thereafter blast was quickest. Apparently rapid conduction of heat away from the surface of the meat accounted for the more rapid initial cooling of the sample in the plate freezer. Even at this low temperature, in still air the zone of maximum ice crystal formation, 31° F. (—1° C.) to 24° F. (—4° C.), is in evidence for 1.8 hours, after which the temperature drops rapidly to —50° F. (—46° C.).

A typical freezing pattern for a 6-inch meat cube at —77° F. (—60° C.) is shown in Figure 4. Thermocouples were placed in the cube at distances 0.5, 1, 2, and 3 in. from the outer surface. The temperature at the 0.5-in. depth dropped quickly and steadily to 10° F. (—12° C.), and at the 1-in. depth to —15° F. (—27° C.), after which the freezing rates became slower. Although the meat at the 0.5- and 1-in. depths passed through the zone of maximum ice crystal formation in a few minutes, the meat at the 2-in. and 3-in.

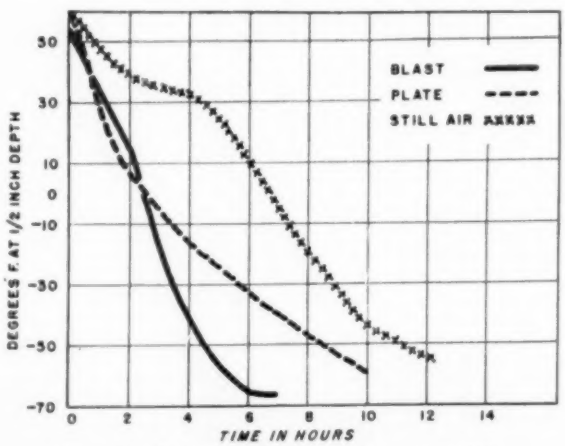

Figure 3. Freezing 6-inch meat cubes at —80° F.

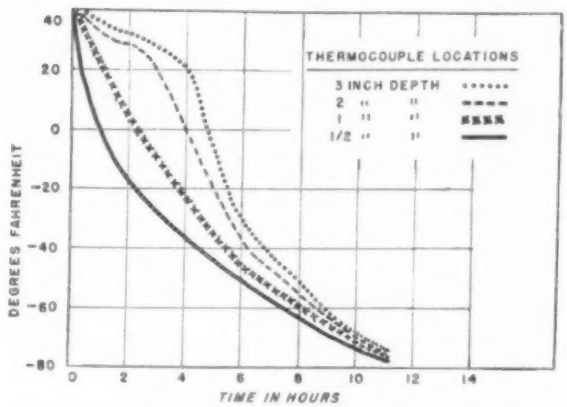

Figure 4. Typical still air freezing pattern at —77° F. for a 6-inch cube.

depths took 1.1 hours. The greatest time differential to the same temperature between the 0.5 and 3-in. depths occurred at 10° F. (—12° C.). At this point the outer layer required 0.4 hours and the inside of the cube 4.5 hours. After the inner layers of meat had passed through the zone of maximum ice crystal formation there was a tendency for the temperatures to equalize, and become almost coincidental in the later stages. The freezing pattern for samples in the plate freezer and in air blast were similar to those in still air, except that there was considerably less spread between outside and inside meat temperatures.

Figure 5 shows blast, plate, and still air freezing curves at the center of a 6-inch cube in 2° F. (—17° C.) ambient temperature. There was little difference in freezing rates between still air and plate. Blast freezing took 10.5 hours to reduce the temperature to 10° F. (—12° C.), plate and still air freezing took over 17 hours. The temperature passed through the zone of maximum ice crystal formation, 31° F. (—1° C.) to 24° F. (—4° C.), in 4 hours in air blast, and in 10.5 hours in still air and plate freezing.

A comparison of blast freezing at —80° F. (—62° C.) and at 2° F. (—17° C.) is shown in Figure 6. It required only 15 minutes for the temperature of the 6-inch

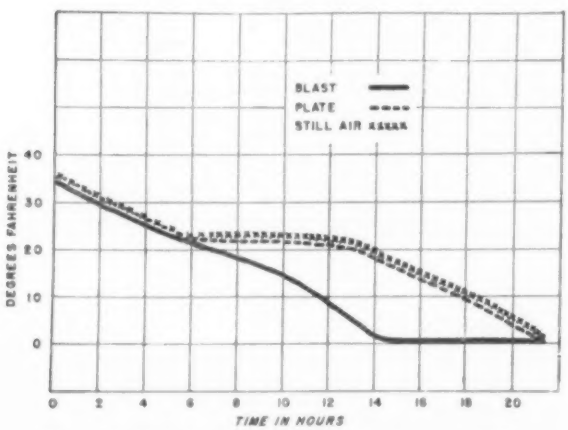

Figure 5. Freezing curves for 6-inch cubes at +2° F.

cube to pass through the critical range 31° F. (—1° C.) to 24° F. (—4° C.) in —80° F. (—62° C.) ambient temperature, but took about 4 hours at 2° F. (—17° C.). At the lower freezing temperature, —80° F. (—62° C.), the sample reached 2° F. (—17° C.) almost 10 times more rapidly than did the sample in air blast at 2° F. (—17° C.).

Although this paper has not included a study of the economics of freezing at very low temperature, it is interesting to speculate the cost of such freezing, particularly when the volume frozen in a given period of time may approach 10 times that frozen at higher temperatures. Where great volumes of meat are being frozen, it might pay dividends.

Weight changes during freezing and thawing. Table 3 contains the data concerning weight losses dur-

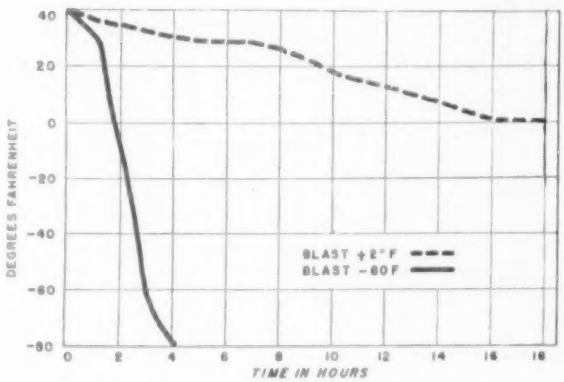

Figure 6. Freezing curves for 6-inch meat cubes.

TABLE 3

Weight loss in meat during freezing and thawing [b]

Type of sample	Frozen at +5° F. (—15° C.)	Frozen at —68° F. (—56° C.)	Temperature of thawed meat: 29° to 33° F. (—2° to 1° C.)	Temperature of thawed meat: 41° F. (5° C.)	Temperature of thawed meat: 75° F. (24° C.)
	%	%	%	%	%
1. Solid Lean Beef	1.5	0.2	0.6	2.3	6.4
2. Ground Fat Pork	0.4	0.1	0.0		
3. Ground Lean Pork	1.1	0.6	0.4		5.3
4. Ground Lean Beef [a]	1.7			2.0	
5. Ground Lean Pork [a]			[c]	1.2	

[b] Freezing carried out in air blast, thawing at 70° F. (32° C.).

[a] Samples 4 and 5 were six by six by three inches, others were six-inch cubes.

[c] Temperature of meat at center and at 0.5 inch depth.

ing freezing and thawing. It should be borne in mind that these samples were six inch cubes or 6 x 6 x 3 in. samples with 6 exposed faces. During freezing at +5° F. (—15° C.) the beef samples showed somewhat greater moisture losses than did the pork with fat pork having the lowest loss. Freezing at —68° F. (—56° C.) resulted in relatively small moisture losses, although in these tests the lean pork showed greater losses than the beef or fat pork. The low moisture losses at —68° F. (—56° C.) are probably due to the low moisture carrying capacity of the air, as well as the possibility that at these very low temperatures, the outer layer of meat forms an ice glaze around the sample within a few minutes, preventing further weight losses.

During thawing at 90° F. (32° C.) ambient temperature and 55% relative humidity, little moisture loss occurred, so long as the meat temperature did not exceed 33° F. (1° C.). When the temperature of the samples was 41° F. (5° C.) and 75° F. (24° C.) appreciable losses occurred as shown in Table 3. Tressler *(9)* reported that with meat having a high moisture content a greater shrinkage can be expected. Increasing the humidity should reduce shrinkage during 90° F. (32° C.) thawing.

Samples thawed to 31° F. (—1° C.) at 40° F. (4° C.) ambient temperature showed no moisture loss. As a matter of interest when the relative humidity was maintained at 90%, some of the samples, especially those which had been frozen to —70° F. (—57° C.), gained 0.1% to 0.2%. The cold meat samples apparently acted as a cold surface condenser in respect to the surrounding air, and moisture was absorbed by the meats. Using thawing temperatures of 70° F. (21° C.) with relative humidity at 75%, if the temperature within the samples did not exceed 31° F. (—1° C.) no moisture losses occurred. There appeared to be some drip loss but most of it was due to moisture condensing onto the sample from the surrounding air. Paul and Child *(5)*, too, reported weight gains in samples of beef thawed at 76° F. (24° C.) with relative humidity at 65%.

Figure 7 shows the rate of thawing of 6-inch meat cubes at 3 temperatures. Samples frozen to —60° F.

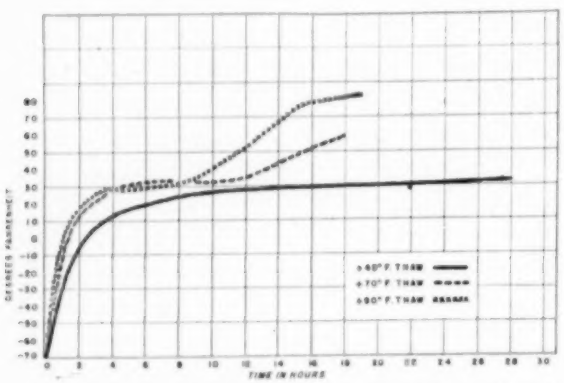

Figure 7. Thawing 6-inch cubes of lean pork at 40°, 70°, and 90° F.

or —70° F. (—51° C. or —57° C.) took 28 hours to thaw to 31° F. (—1° C.) at 40° F. (4° C.) ambient temperature, but only 9 hours at ambient temperatures of 70° F. (21° C.) and 90° F. (32° C.). Other samples, not shown, frozen to 2° F. (—17° C.), required from 24 to 26.2 hours to thaw to 31° F. (—1° C.) at 40° F. (4° C.) in air temperature, and 7.5 hours when thawed at 70° F. (21° C.) or at 90° F. (32° C.). It does not require much more time to thaw very cold samples than it does if the sample temperature is 2° F. (—17° C.).

At 70° F. (21° C.) and 90° F. (32° C.), thawing temperatures are practically coincidental through the range of maximum ice crystal thawing; then they diverge in favor of the higher temperature.

SUMMARY AND CONCLUSIONS

Freezing and thawing rates of meat are affected by type of wrapping, composition, size, and shape of sample, ambient temperatures, and methods of freezing.

Wrappers decreased freezing rates as much as 50%.

Solid and ground lean meat, and meat with the same amount of fatness froze at the same rates.

A 6 x 6 x 3 in. sample required a little more than half the time to freeze than did a 6-inch cube.

A 7.5 pound 6-inch cube of lean meat in air blast at 2° F. (—17° C.) ambient temperature, took 12.2 hours to chill from 37° F. (3° C.) to 10° F. (—12° C.). Still air took 58% and plate freezing 32% longer. At —68° F. (—56° C.) in air blast, the sample temperature was 10° F. (—12° C.) in 2.5 hours and —50° F. (—46° C.) in 3.2 hours.

Freezing curves are shown for temperatures of 6-inch cubes at 0.5 to 3 in.-depths, in air blast, plate or still air freezing at ambient temperatures from 2° F. (—17° C.) to —80° F. (—62° C.).

Thawing curves at 40° F. (4° C.), 70° F. (21° C.), and 90° F. (32° C.) are presented, as well as a table showing weight changes during freezing and thawing.

LITERATURE CITED

1. Du Bois, C. W., and Tressler, D. K. Influence of rate of freezing and temperature of storage on quality of frozen meats. *Proc. Inst. Food Technologists* (1940).
2. Hiner, R. L., Madsen, L. L., and Hankins, O. G. Histological characteristics, tenderness and drip losses of beef in relation to temperature of freezing. *Food Research*, **10** (4) (1945).
3. Jensen, L. B. *Meat and Meat Foods*. 1949. The Ronald Press Co., New York, N. Y.
4. Moran, T. Rapid freezing. Critical rate of cooling. *J. Soc. Chem. Ind.*, **51**, 16T-20T (1932).
5. Paul, P., and Child, A. M. Effect of freezing and thawing beef muscle upon press fluid losses and tenderness. *Food Research*, **2**, 339-347 (1937).
6. Poole, G. Recent progress in quick freezing. *Refrig. Eng.*, **29**, 69-73 (1935).
7. Ramsbottom, J. M., Goeser, P. A., and Strandine, E. J. The effect of different factors on the freezing rate of meats. *Refrig. Eng.*, **57** (12) (1949).
8. Refrigerating Data Book. *Refrigeration Applications Volume*. Third ed., 1950. The American Society of Refrigerating Engineers, New York, N. Y.
9. Tressler, D. K., and Evers, C. F. *The Freezing Preservation of Foods*. 1947. The Avi Publishing Co., Inc., New York, N. Y.

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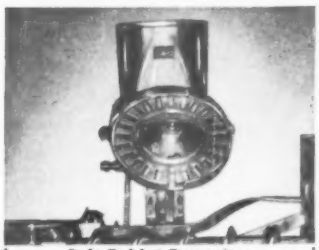

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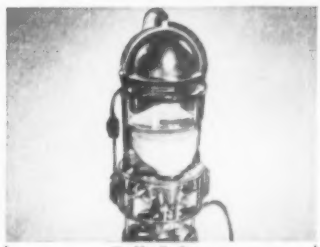

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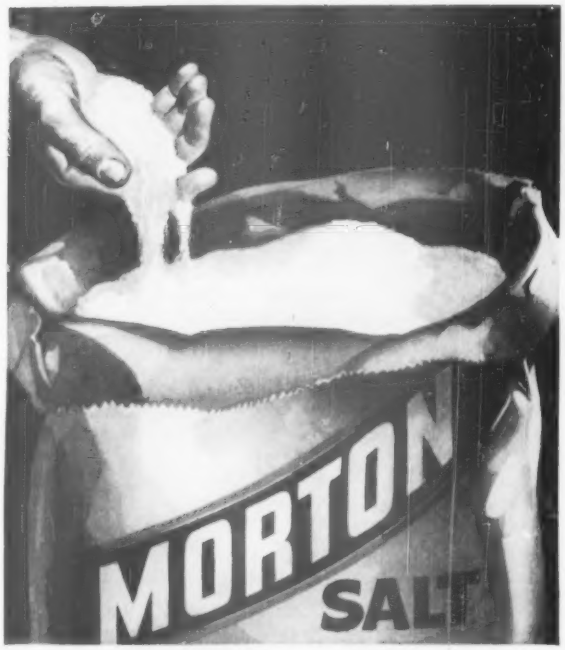

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ANNUAL MEETING BULLETIN BOARD

(Continued from page 28 preceding technical papers)

ever, evidence concerning factors affecting the reliability of the methods has been rather meager and Dr: Hanson feels that papers reporting actual experimental evidence on the influence of test conditions on the reliability of results would be welcomed by all who are faced with the problem of selecting methods to use. The invitation is still open, therefore, to authors of papers concerned with critical evaluation of methods of consumer testing.

Dr. Joseph R. Wagner, whose symposium on dehydration techniques is a comparative newcomer on the program, is coordinating his program with an exhibit and demonstration of dehydrated products. He is interested in receiving additional worthwhile papers based on experimental work completed within the recent past. For those who may not have followed progress in dehydration in recent years this program will reveal some surprising advances.

Books

ADVANCES IN FOOD RESEARCH, Vol. IV. Edited by E. M. Mrak and G. F. Stewart. 457 pages, IX. Academic Press, Inc., New York. $8.00.

The fourth volume of *Advances* is a continuation of the editors' efforts to provide a series of publications for a complete coverage of progress in food research. The present volume contains a discussion of nine subjects: Wiltshire Bacon, N. E. Gibbons; Work Methods Design and Work Simplification, Louis E. Davis; Nutritional Stress Factors and Food Processing, Samuel Lepkovsky; The Chemistry of Chlorophyll (with Special Reference to Foods), S. Aronoff; Reversion Problems in Edible Fats, B. F. Daubert and Paul W. O'Connell; Fish Preservation in Southeast Asia, A. G. van Veen; The Effects of Heat Upon the Nutritive Value of Protein, Eldon E. Rice and Jack F. Beuk; Insects Attacking Stored Products, A. E. Michelbacher; The Use of Ascorbic Acid in Processing Foods, J. C. Bauernfeind.

Some readers may question the appropriateness of a chapter on work methods design and work simplification in a volume on food research. Such a subject would seem to belong in the field of industrial engineering rather than in the domain of food research. Many of the "nutritional stress factors" described so well in the corresponding chapter appear to fall within the category referred to in recent times as "antimetabolites," yet this term has not been used. While the reviewer holds no brief for either terminology, it might have been well to indicate their relationship.

It is noted that Agene is listed in Table II (p. 115) as one of the deleterious compounds found in foods not normally occurring as a food constituent. The use of Agene has been prohibited in flour bleaching in the United States since August 1, 1949. In the same table, the reader may be led to believe that sulfites in foods cause a hemophilia. Nothing is said about the amount of sulfites required to bring about this condition.

These criticisms are minor and do not detract from the value of the book. The food technologist will find this volume a valuable addition to his reference library beside the other three volumes of *Advances*.

HARRY W. VON LOESECKE,
Washington, D. C.

ESSENTIALS OF PHYSIOLOGICAL CHEMISTRY, 4th Edition. Arthur K. Anderson, John Wiley and Sons, New York, 1953, 480 pages.

The book is written especially to give a basic knowledge of biochemistry to students who possess a limited background in chemistry and biology. It seems well designed to satisfy such functions even though the field is ever increasing. The language is direct and the sequences of facts simple and not complicated with too much detail. When chemical reactions are described, the formulas and equations are kept elementary and graphic. Such a portrayal as the tricarboxylic acid cycle in intermediary metabolism includes the essentials and is up to date within the year. The type is easily legible and bold face used in moderation so that the student can readily pick out emphasis upon certain key words. The question list at the end of each chapter should be another aid in pointing out to the student with less background the points to be remembered.

The text has been brought up to date by other inclusions of brief sections describing new discoveries which have been well integrated with the original material. These new subjects include such items as isotopes, antivitamins and material concerned with vitamin B_{12}. In a few places changes of more than a year ago have not been noted but these are usually minor. A few typographical errors appear but these also do not appear major.

One departure from the usual organization is the inclusion of the digestive hormones in the section on the endocrines. Discussion of both hormones and enzymes are likewise included in the previous discussion on digestion, but the further emphasis may serve to separate the concept of enzymes and hormones in the student mind.

MARGARET G. MOREHOUSE,
Los Angeles, California.

REFRIGERATION IN AMERICA. Oscar Edward Anderson, Jr. Published for the University of Cincinnati by Princeton University Press, Princeton, N. J. (1953), 344 pp. and index, 10 figures. Price $6.00.

Despite its relatively short length, this book is a comprehensive history of the rise of refrigeration in America and its influence on the food supply of this country. An amazing amount of information is contained within its 344 pages. The author traces the rapid rise of the use of ice from 1830 to well into the Twentieth Century, the gradual development of mechanical refrigeration from 1863 to 1880, and the tremendous expansion of its use since then. The use of natural ice, the manufacture of ice, commercial and domestic refrigeration, refrigerated transport, air conditioning, food freezing and many other uses for refrigeration are discussed in detail.

The food technologist will be particularly interested in chapters dealing with Refrigeration and the Produc-

(Continued on page 36)

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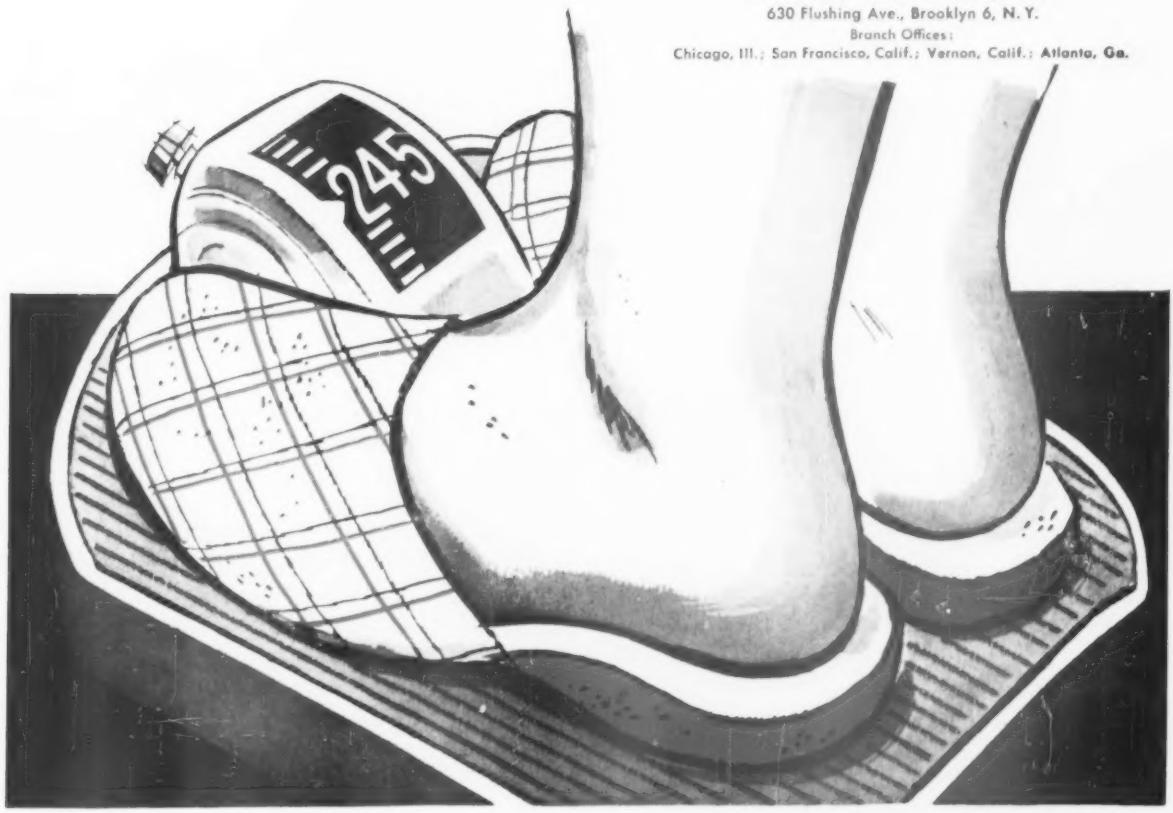

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BOOKS

(Continued from page 34)

tion and Distribution of Food, 1890-1917," "Cold Storage: Improvement and Acceptance," "Food Production and Distribution, 1917-1950," "Frozen Foods: The Introduction of a New Technology," "Rural Refrigeration: Locker Plants and Home Freezers, 1917-1950." Considering the fact that the book was written by a historian, the reader will be surprised by the author's familiarity with the principles of refrigeration and food preservation, and the evident understanding of food processing and distribution. The rise of the modern meat packing, poultry, and dairy industries and their dependence on refrigeration is especially well presented.

Those interested in food freezing will find this book useful not only for its excellent review of the rise of the industry but for the large number of references to the best review articles and books on the subject. In fact, everyone interested in either food technology in particular, or refrigeration in general, will find the very extensive bibliography a useful key to the literature on these subjects.

Taken as a whole, the book is very well written, it is comprehensive and yet presents details; notwithstanding this, it is easy to read; certainly it merits a place in the private library of every food technologist.

DONALD K. TRESSLER,
Chicago, Illinois.

FUTURE DATES FOR FOOD TECHNOLOGISTS

1953	
December 13-16	Annual Meeting of the American Institute of Chemical Engineers, St. Louis, Missouri
December 26-31	Annual Meeting of the American Association for the Advancement of Science, Boston, Massachusetts
1954	
January 18-20	National Potato Chip Institute, Cincinnati, Ohio
January 22	National Poultry and Egg Board Meeting, Chicago, Illinois
January 22	Annual Meeting of the National Wooden Box Assocation, Chicago, Illinois
January 31-February 1	Meeting of the American Dehydrators Association, New Orleans, Louisiana
February 1954	Annual Meeting of the National Soup Mix Association, Chicago, Illinois
February 1-4	Frozen Food Industry Convention and Exhibition, New York, New York
April 22-23	National Meeting of the American Dry Milk Institute, Cleveland, Ohio
May 2-5	Annual Meeting of the National Fisheries Institute, Cleveland, Ohio
May 26-28	*Fourth Annual Convention, Australian Regional Sections, Institute of Food Technologists, Leura, New South Wales, Australia.*
June 23-25	Seventh Annual Meeting of the Research and Development Associates, Food and Container Institute, Los Angeles, California
June 27 to July 1, 1954	**Fourteenth Annual Meeting of the Institute of Food Technologists, Los Angeles, California**

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)

Selected Abstracts*

ANALYTICAL METHODS

The determination of semi-micro quantities of formic acid.

HOPTON, J. W. *Anal. Chim. Acta, 8,* 429-31 (1953).

A method is described for the detn. of small amts. (ca. 0.1 mg.) of formic acid. Mercuric chloride, in acetate-buffered soln., is reduced to calomel by formate. The calomel produced is detd. iodometrically.

Chromatostrips for identifying constituents of essential oils.

MILLER, J. M., AND KIRCHNER, J. G. *Anal. Chem., 25,* 1107-9 (1953).

The components of essential oils cannot be positively identified by means of R_f values on chromatostrips, although many compds. can be eliminated by comparison of R_f values. Many reactions can be performed directly on the chromatostrip and the products chromatographed or the reaction can be carried out on a micro scale in a test tube and the reaction mixt. chromatographed. These reactions include oxidation, reduction, dehydration, hydrolysis, and formation of derivs. A list of R_f values, in a variety of solvents, of many terpenes and oxygenated terpenes found in essential oils is included.

Determination of caffeine and trigonelline in coffee by paper chromatography.

KOGAN, L., DI CARLO, F. J., AND MAYNARD, W. E. *Anal. Chem., 25,* 1118-20 (1953).

Coffee is extd. by boiling with dil. H_2SO_4. The ext. is treated with MgO to remove most of the chlorogenic acid. It is then chromatographed using 65% isopropanol-2*N* HCl. The caffeine and trigonelline spots are located by fluorescence under ultraviolet light, cut out, eluted with 0.1*N* HCl, and measured by ultraviolet absorbency.

Chromatographic separation of vanillin from coumarin.

NIVOLI, M. *Ann. Chim. (Rome), 43,* 38-9 (1953); Brit. *Abstr. C., 274* (1953).

The sepn. of vanillin from coumarin by adsorption chromatography on a column of alumina at pH 3-3.5 and 5, using toluene as solvent and eluent, is described. Good results are obtained using Merck alumina treated with HCl, washed to a pH of 3-3.5, dried at 400°-500° then left in the air for 3 hrs. This alumina has properties corresponding to the 4th degree of Brockmann's series. All the vanillin is adsorbed in the first part of the column, while coumarin is scarcely retained and can be eluted completely with relatively small amts. of toluene. At pH 5 the results are better inasmuch as all the vanillin is adsorbed in a smaller section.

The wet ashing of organic matter employing hot concentrated perchloric acid: the liquid fire reaction.

SMITH, G. F. *Anal. Chim. Acta., 8,* 397-421 (1953).

The wet ashing of a wide variety of org. compns. by the action of hot concd. perchloric acid together with and without nitric acid and vanadium as catalyst is described. The study in detail was made of the wet oxidation of a wide variety of natural products in 1 to 10 g. sample magnitudes. App. design and reaction limitations are described. Samples of carbohydrates, cellulose products, proteins and hydrocarbons in various natural org. products were studied. The reaction mechanism is postulated, the influence of vanadium as catalyst studied and temp. effects demonstrated. New analytical applications are suggested.

Identification of polymorphic forms of crystals by infrared spectroscopy.

KENDALL, D. N. *Anal. Chem., 25,* 382-9 (1953).

Infrared technics can be conveniently and successfully applied to distinguish between different cryst. forms of substances of the

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Associate Editor H. A. Campbell and the General Foods Corporation of New York, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

(Continued on page 38)

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SELECTED ABSTRACTS

(Continued from page 36)

same chem. compn. Infrared spectroscopy was applied to the identification and detn. of polymorphic forms of both org. and inorg. crystals. The method complements and supplements the x-ray, microscopical, and electron diffraction technics. The advantages and disadvantages of these technics for study of polymorphism are discussed.

Viscosity measurement of non-Newtonian liquids.

EPPRECHT, A. G. *Chim. anal., 35,* 3-8 (1953); *Brit. Abstr., C, 237* (1953).

An elementary discussion of viscosity is followed by a brief description of a rotating cylinder viscometer and its use in distinguishing various types of non-Newtonian behavior. Rheological illustration is mainly concerned with the paint industry.

Automatic thermometric titrations.

LINDE, H. W., ROGERS, L. B., AND HUME, D. N. *Anal. Chem., 25,* 404-7 (1953).

With a relatively simple app. consisting of a thermistor, recording potentiometer, and constant-flow buret, a wide variety of titrations may be carried out automatically with ease, speed, and accuracy. Good results were obtained with strong acid-strong base reactions; the titrations of acetic, boric, and phosphoric acids (the latter gives three clearly defined breaks); the detn. of weak bases, such as ammonia, and heterocyclic amines; and pptn. and ion-combination reactions such as those of chloride with silver or mercuric ions. The method was applied with success to systems contg. emulsions, thick slurries, and org. solvents, and was shown to be applicable over a wide range of concns.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

Radiation Research Society meeting.

Chem. Eng. News, 31, 2774 (1953).

Mutations caused by chemicals differ from those due to radiation. X-rays break the chromosomes along their entire length, while chem. action breaks them in only one place. There is also a difference in the stage of cell division at which the exposur has its max. effect. Compds. contg. carbon-14 decompose as a result of self irradiation. The necessity for frequent checking of labeled C^{14} compds. to ensure validity of exptl. results is pointed out.

Catalase assay with special reference to manometric methods.

BEERS, R. F., AND SIZER, I. W. *Science, 117,* 710-12 (1953).

The criteria which must be met by quant. methods for studying the rate of peroxide breakdown by catalase are outlined. Applications of these criteria to manometric methods are illustrated.

Fat metabolism in prolonged physical work.

YAKOVLEV, M. M. *J. Physiol., U.S.S.R., 38,* 332-6 (1952); *Brit. Abstr. B III, 72* (1953).

Blood ésths. in athletes taking part in 10,000 m. running and walking races showed an increase in total blood-fat and decrease in phospholipins following exercise. Rats undergoing forced swimming for 3-9 hrs. showed similar changes, and in this case there was also found fatty infiltration of the liver. Feeding with lipotropic substances, choline and methionine, prevented the development of the fatty infiltration.

Inactivation of barley β-amylase by sodium dodecyl sulfate.

MYRBACK, K., AND PERSSON, B. *Arkiv Kemi, 4,* 531-6 (1952); *Biol. Abstr., 27,* 1763, No. 19046 (1953).

Barley β-amylase is strongly inactivated by Na dodecyl sulfate. Inactivation takes place only in acid soln. below pH 5.1. The enzyme, once inactivated in acid soln., is not reactivated at above pH 5.1, indicating that the inactivation is not simply a salt formation between basic groups of the enzyme and the dodecyl sulfate ion. The inactivation by dodecyl sulfate, in contrast to that by heparin, is only slightly affected by NaCl. Substrate and maltose protect the enzyme against the action of dodecyl sulfate, indicating that substrate-binding basic groups are involved in the attachment of the dodecyl sulfate ion.

Oat lipase and tributyrin.

PEERS, F. G. *Nature, 171,* 981-2 (1953).

The action of oat lipase on tributyrin was studied. Lipase was unable to attack di- or monobutyrins and attacks tributyrin by removing one fatty acid chain only. From the b.p. and sapon. nos., it was concluded that the β-linkage was the one hydrolyzed and that the diglyceride was α, γ-dibutyrin.

BOTANY AND AGRICULTURAL CHEMISTRY

Effect of gamma irradiation on the ascorbic acid content of green plants.

COOKE, A. R. *Science,* 117, 588-9 (1953).

There is an apparent correlation between the initial ascorbic acid content and the relative resistance of a plant to irradiation. It appears that ascorbic acid may offer a protecting action against irradiation in plants.

MICROBIOLOGY

The application of the agar-strip method for determining colony counts of milk and water.

GEORGE, G., GRIFFITHS, D. G., AND THOMAS, S. B. *Lab. Practice, 2,* 294-6 (1953).

Agar-strips can be employed, instead of Petri plates, as an economical screening test where the object is to det. the approx. range of colony counts during advisory surveys or to detect milk supplies with high counts, e.g. thermoduric colony counts over 10^4/ml. Agar-strips cannot be recommended for detg. colony counts when accuracy is important or standard procedures are prescribed.

A new procedure for bacterial viability counts and its biophysical applications.

VALENTINE, R. C., AND BRADFIELD, J. R. G. *Nature, 171,* 878 (1953).

Cultures are incubated in 3% urea-nutrient agar. This permits growth while inhibiting division. Live organisms grow to many times the size of the dead ones and are counted in an electron microscope.

Further study of Streptococcus salivarius as an index organism in the sanitation of eating utensils.

HIGGINS, R. D., AND TAYLER, J. R. *Sanitarian, 15,* 218 (1953).

Methods are given for culturing *Streptococcus salivarius.*

NUTRITION

An approach toward ideal in parenteral nutrition.

STRICKLER, J. H., AND RICE, C. O. *Minnesota Med., 36,* 221 (1953); *J. Am. Med. Assoc., 152,* 972-3 (1953).

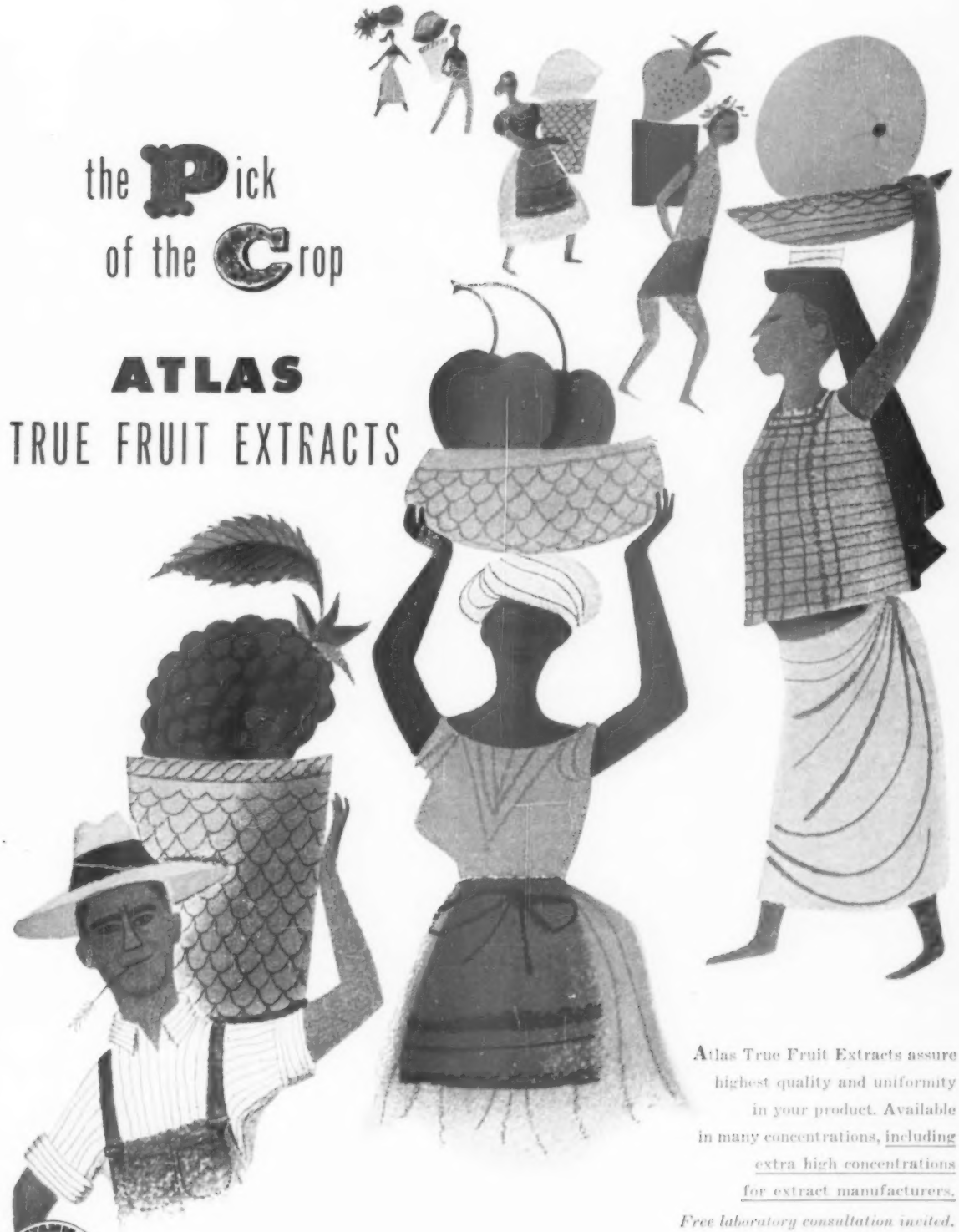
A soln. contg. 12% invert sugar, 6% amino acids and 4% alc., which furnishes 1,000 cal./l. and approaches the ideal proportion in terms of normal human intake of the various food substances was studied in 57 cases. Results showed that invert sugar can be used in greater concn. without producing as much hyperglycemia or glycosuria as is produced from equiv. percentage of glucose. Addnl. evidence is presented supporting the thesis that parenteral protein requires adequate caloric intake for optimal utilization of amino acids.

Effect of amount and type of protein in breakfasts on blood sugar levels.

ADDISON, V. E., TUTTLE, W. W., DAUM, K., AND LARSEN, R. *J. Am. Dietet. Assoc., 29,* 674-7 (1953).

Data were collected from a group of 14 normal women between the ages of 20 and 37 years, relative to the effect of the

(Continued on page 41)



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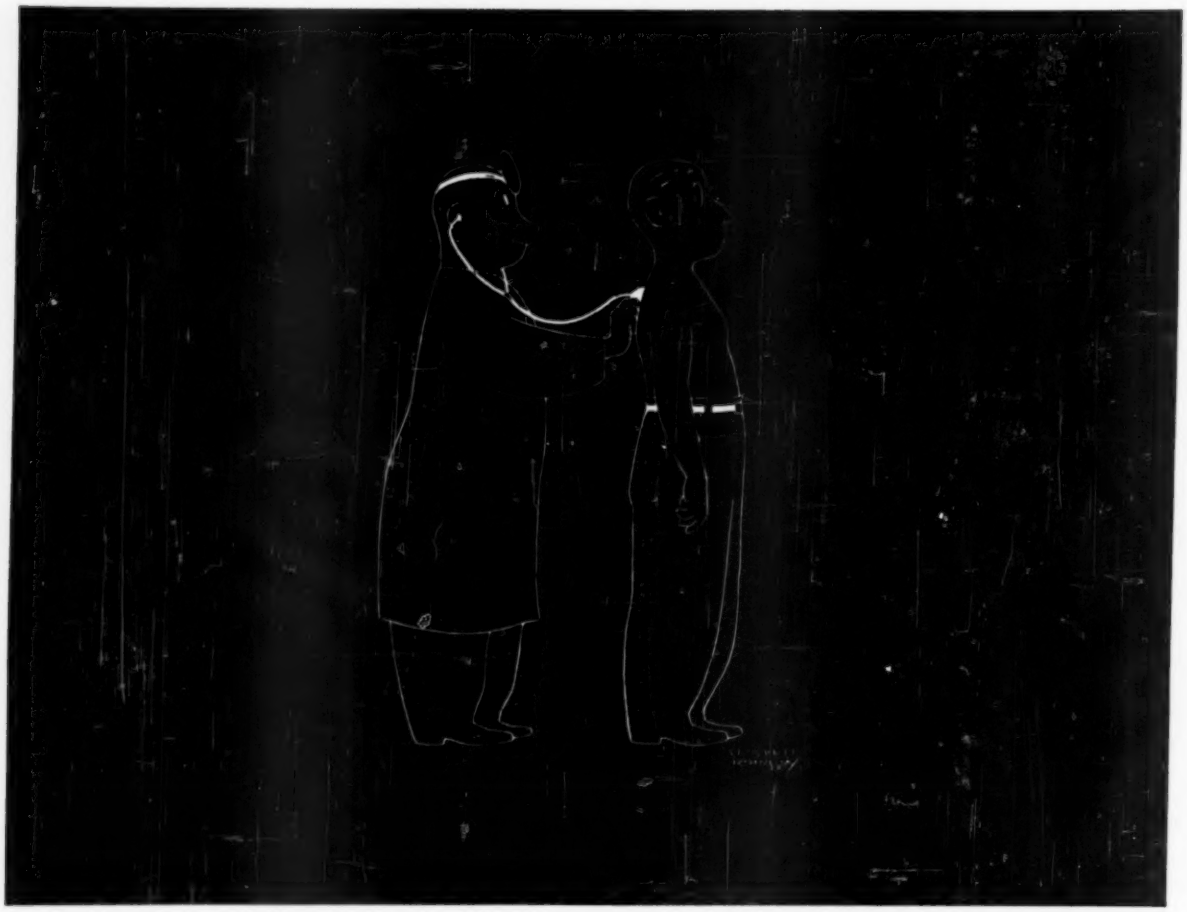

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American Cancer Society

SELECTED ABSTRACTS

(Continued from page 38)

source and amt. of protein in breakfast on the maintenance of the blood sugar level following the meal. On the basis of the data presented, the following conclusions are drawn: Although 15 g. protein in the breakfast were not sufficient to maintain the blood sugar at or above the fasting level for a period of 3.5 hrs. after the meal, the fall below the fasting level was not significant at any sampling period. The data suggest that 15 g. protein in breakfast is on the borderline with respect to maintaining the blood sugar at or above the fasting level for 3.5 hrs. after the meal. Whether the protein is of plant or animal origin seems to be of no consequence, since the blood sugar behaves very similarly following the ingestion of similar breakfasts contg. the same amts. of the two kinds of protein.

The influence of energy intake on protein metabolism.

MUNRO, H. N., AND NAISMITH, D. J. *Biochem. J., 54,* 191-7 (1953).

When the diet provided to rats contained adequate protein, the relationship of N balance to energy intake was linear with no break at or near N equil. In a protein-free diet, no change in N balance occurred when fat equiv. to 900-1700 kg. cal./sq. m. was fed. Addn. of carbohydrate produced some improvement up to 1200 kg. cal./sq. m. but not thereafter. In neither case was the amt. of protein in the liver significantly altered.

Nutrition and resistance to infection.

SCHNEIDER, H. A. *Borden's Rev. Nutrition Research, 14,* 17-32 (1953).

A review. 30 references.

Bacterial cultures in the nutrition of poultry. I. Effect of dietary bacterial cultures on the growth and cecal flora of chicks.

ANDERSON, G. W., SLINGER, S. J., AND PEPPER, W. F. *J. Nutrition, 50,* 35-46 (1953).

Supplementing a diet for chicks with certain microorganisms isolated from the ceca of chicks fed penicillin resulted in improved wt. The feeding of a culture of one atypical strain of *E. coli* caused a significant wt. response in the absence of dietary penicillin. The feeding of typical *E. coli* and two atypical strains of *E. coli* in the presence of dietary penicillin resulted in wts. considerably greater than those achieved with the microorganisms or penicillin alone. Part of the activity of a mixed coliform culture was found to be present in the filtrate and part in the viable organisms themselves. A culture of micrococci depressed growth in the absence of penicillin but this inhibition was completely relieved in the presence of dietary penicillin. The feeding of a culture of anaerobes did not improve wt. but increased feed efficiency. There appeared to be a synergistic interaction between penicillin and certain of the bacterial cultures fed.

Studies on nutrition of poultry. III. Toxicity of grain sorghum for chickens.

MCCLYMONT, G. L., AND DUNCAN, D. C. *Australian Vet. J., 28,* 229-33 (1952); *Biol. Abstr., 27,* 1856, No. 19942 (1953).

A toxic factor in grain sorghum depresses growth up to 50% when rations contain 63% of such sorghums. Below 28% sorghum in rations there is no significant growth depression. The higher levels of sorghums increase mortality rate. Growth depression continued up to 26 weeks of age.

Difference in the caries-producing effects of two purified diets containing the same amount of sugar.

WYNN, W., HALDI, J., SHAW, J. H., AND SOGNNAES, R. F. *J. Nutrition, 50,* 267-74 (1953).

Litter mates of both albino rats and cotton rats were fed two synthetic diets that differed quantitatively in a considerable no. of their constituents but were identical in their sugar content. One of these diets proved to be much more cariogenic than the other, indicating that the sugar content of the diet does not necessarily provide a measure of its cariogenicity.

Nutritional deficiencies in mice caused by stress agents.

BOSSHARDT, D. K., AND HUFF, J. W. *J. Nutrition, 50,* 117-27 (1953).

Feeding to growing mice of a low fat diet complete with regard to all known dietary essentials results in what is regarded as normal growth. The addn. to this diet, however, of such metabolic stresses as are brought about by the intestinal bacteriostatic agents, succinylsulfathiazole, streptomycin or atabrine, or such materials as thyroid or triacetin, causes a retardation of growth. This growth retardation can be prevented if to the stress-contg. basal diet are added fat, fatty acids, or such low fat materials as a partially defatted cottonseed meal or a water-extd. liver residue. It is concluded tentatively that the stresses employed interfere with the synthesis of long chain fatty acids by the organism. It is further suggested that cottonseed and liver contain a factor, or factors, essential for the synthesis of fat by the animal.

PHARMACOLOGY AND TOXICOLOGY

National Safety Council plan evaluates toxicity of new chemicals.

Chem. Eng. News, 31, 2719 (1953).

Descriptions of five proposed tests are given: single oral doses, skin penetration, inhalation, skin irritation, eye damage. A proposed evaluation of the data considers six levels of toxicity, ranging from "dangerously toxic" to "extremely low acute toxicity." Dosage ranges of LD_{50} (in mg./kg.) and probable lethal dose for a 70-kg. man are given for each level.

The toxicity of coumarin.

JACOBS, M. B. *Am. Perfumer Essent. Oil Rev., 62,* 53 (1953).

Review of literature information on physiol. effects of ingestion of coumarin, pointing out predominance of animal work and paucity of observations on humans.

Parathion poisoning in citrus grove operations in 1951.

WILLIAMS, J. W., GRIFFITHS, J. T., AND STEARNS, C. R. *Florida Med. Assoc. J., 39,* 655 (1953); *J. Am. Med. Assoc., 152,* 1071 (1953).

Of 28 cases of supposed parathion poisoning, 9 cases were confirmed as due to parathion poisoning by blood cholinesterase tests, 8 were probably due to parathion poisoning. All but one of the 9 authenticated cases were exposed to parathion spray for more than 10 days. The histories of 13 patients are presented. Those of the 9 authenticated cases of parathion poisoning emphasize the extreme importance of regular blood examns. during parathion exposure and the necessity for immediately removing a man from exposure if the red blood cell cholinesterase values drop below 70% of normal. One case suggests that in order for cholinesterase tests to be valid diagnostic aids, they must be made immediately after the patient becomes ill, as in some cases the cholinesterase levels return to normal quickly. The 4 other case histories suggest that the use of alc. beverages by those exposed to parathion may precipitate or aggravate symptoms of poisoning.

PHYSIOLOGY AND MEDICINE

Blood surplus in liver in sudden allergy deaths.

Science News Letter, 63, 296 (1953).

When a tiny amt. of egg white was injected into already egg-white allergic guinea pigs, tiny blood vessels in the liver went into spasm within seconds afterwards. This prevented blood from flowing out of the liver though for a time blood continued to flow into the liver. The liver rapidly filled with blood and shortly thereafter allergic spasm of other blood vessels stopped further flow of blood into it. The large vol. of blood trapped by the liver was not available to the rest of the body and within a few mins. the animal died.

Appetite center in brain.

Science News Letter, 63, 277 (1953).

It appears that there exist in the hypothalamus two areas, in

SELECTED ABSTRACTS

close proximity to each other, which exert opposite effects on food intake.

Influence of fats and fatty acids on the capillaries.

KRAMAR, J., AND LEVINE, V. E. *J. Nutrition, 50,* 149-60 (1953).

The capillary resistance and capillary permeability of the immature albino rat were studied under various dietary conditions. When the animals were fed a synthetic diet practically devoid of fat and fatty acids, or a synthetic diet contg. 5% methyl stearate, the capillary resistance began to decline about the 50th day of the expt. and dropped to pathologically low levels. If the same basic diet contd. 5% corn oil, the capillary resistance remained normal. This drop in capillary resistance occurred simultaneously with the flattening of the wt. curve, but before the characteristic manifestations of fat deficiency had developed. The low capillary resistance of fat-deficient rats was promptly restored by minute amts. of linseed oil or cottonseed oil or pure linoleic acid.

Synthesize polypeptides.

Science News Letter, 63, 385 (1953).

Substances known as lysine polypeptides and related compds., which affect some viruses and bacteria in much the same way as the antibodies that create immunity, were synthesized. While the polypeptides themselves are at present probably too toxic to be used against disease germs in humans, they may eventually help give medicine new weapons against bacterial and virus infections. The lysine polypeptides force virus particles and bacteria to clump together. Growth and respiration are inhibited. This is what happens to bacteria and viruses when they are attacked by natural body defense agents. Among the microorganisms against which the lysine polypeptides were effective are the influenza virus, fowl bronchitis virus, Newcastle disease virus, tobacco mosaic virus, a bacteriophage or virus attacking bacteria and the bacillus that causes anthrax.

ENGINEERING AND PLANT EQUIPMENT

Atomization by centrifugal pressure nozzles.

TATE, R. W., AND MARSHALL, W. R. *Chem. Eng. Progr., 49,* 226-34 (1953).

Graphs and equations are presented describing the effects of basic nozzle properties on spray characteristics. The work was based on the belief that the diam. of the nozzle orifice, the liquid vertical velocity component, and the tangential velocity component of the liquid were the three fundamental variables sufficient to describe any pressure nozzle operation and design.

Cost estimation for process operations.

SCHWEYER, H. E. *Chem. Eng. News, 31,* 3266-70 (1953).

A list of basic data required for making a complete cost estimation is given. An abbreviated list of cost indices for various years is included and a table of factors for estg. the complete plant investment cost is given. Addnl. figures and tables give charts for handling cost estimate problems and annual cost of sales figures.

FOOD AND FOOD TECHNOLOGY

BAKING AND BAKERY PRODUCTS

Susceptibility of the starch in fresh and stale bread to enzymatic digestion.

Science, 118, 18-19 (1953).

Stale bread is less readily digested under *in vitro* conditions than fresh bread. Inclusion of bacterial α-amylase in the bread formulation prevents the decrease in rate of digestion and decreases the rate of staling.

DEHYDRATED AND FROZEN FOOD

At-plant vining is held heart of quality pea processing.

Quick Frozen Foods, 15, 48-9+, June, 1953.

A description is given of the processing of frozen peas. Included is a chart showing the effect of delay between harvest and freezing on the color, flavor and cotyledon and skin textures of peas.

Catalase vs. peroxidase as indicator for adequacy of blanch of frozen vegetables.

COBEY, H. S., AND MANNING, G. R. *Quick Frozen Foods, 15,* 54+, May, 1953.

Rapid methods for testing catalase and peroxidase in vegetables are described. A modification of the Thompson manometric method is used for catalase and a spot plate test is used for peroxidase. Both methods are considered suitable for plant and field control work.

FRUIT AND FRUIT JUICES

Citrus flavoring. Volatile water-soluble constituents of grapefruit juice.

KIRCHNER, J. G., MILLER, J. M., RICE, R. G., KELLER, G. J., AND FOX, M. M. *J. Agr. Food Chem., 1,* 510-12 (1953).

Studies of the chem. changes taking place in volatile water-sol. constituents of grapefruit juice were made. While very little difference was found between freshly extd. and freshly canned juices, distinct changes were observed in canned juice which had been stored at room temp. for four years. Small amts. of acetic acid and two unsatd. acids were found in the freshly canned juice, along with a trace of furfural. The stored canned juice contained H_2S and considerably increased volatile acids, MeOH and furfural.

Fruit color loss: effects of carbohydrates and other factors on strawberry products.

MESCHTER, E. E. *J. Agr. Food Chem., 1,* 574-9 (1953).

Pigment extd. from strawberry juice with 1-butanol was used to study effects of various materials on the loss of color. The data show that temp. and pH value have a great effect on the rate of pigment loss. Salt concn. affects the rate of pigment loss in strawberry juice. The effect seems to be related to the presence of sugars, as a similar effect is not observed in the reaction with extd. pigment when no sugars are present. Both ascorbic acid and dehydroascorbic acid change the magnitude of the rate of pigment loss. Both furfural and hydroxymethylfurfural increase the rate of pigment loss, and because these compds. are typical of sugar degradation products, it is strongly suggested that sugar deterioration products react with the pigment of strawberry preserves. Materials present in strawberry juice itself (probably sugars) apparently have an appreciable effect on rate of pigment loss.

LEGISLATION

The new patent law. How does it affect the chemical engineer?

YOUNG, P. L. *Chem. Eng. Progr., 49,* 223-5 (1953).

A new patent law went into effect Jan. 1, 1953. This law represents about 90% of a codification of the existing law with minor modifications and about 10% broader changes. Three important changes have been made which have a particular bearing on the chem. industry. The first deals with contributory infringement and re-establishes this doctrine. The second deals with the new use of an old product and states that the new use may be inventive. The third change attempts to correct the great hazard of inventorship. Several suggestions pertaining to patents are given, such as: (1) keeping records, (2) detg. the scope of a patent, and (3) how much an inventor should know concerning patents.

ORGANIC CHEMISTRY

Reactions of aliphatic amines with sugars.

ERICKSON, J. G. *J. Am. Chem. Soc., 75,* 2784 (1953).

Reactions of long-chain primary aliphatic amines with sugars can go far past the amine glycoside stage. As many as 5 or 6 moles of amine have reacted with one mole of hexose sugar. In effect, these reactions are replacement of OH groups by alkyl-

(Continued on page 44)

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SELECTED ABSTRACTS

(Continued from page 42)

amino groups. The actual mechanism of the reaction, however, is probably a series of Amadori rearrangements, each followed by reaction of the carbonyl group so formed with another mole of amine. The findings suggest new approaches to the study of the browning reaction.

PHYSICAL RESEARCH

The flow of emulsions. II.

RICHARDSON, E. G. *J. Colloid Sci., 8, 367-73* (1953).

The apparent viscosity of emulsions having the same concn. and the same size distribution about a mean globule diam. is inversely proportional to this mean diam. The observed variations of viscosity of a concd. emulsion with concn. and rate of shear can be explained in terms of the work done in distorting the globules and sliding them past each other.

Use of thermistors in precise measurement of small temperature differences. Thermometric determination of molecular weights.

MUELLER, R. H., AND STOLTEN, H. J. *Anal. Chem., 25,* 1103-6 (1953).

The selection of a high-resistance thermistor and circuitry applying to the precise measurement of small temp. differences is described. Tables of data concerning thermistor characteristics, their reliability and reproducibility were obtained. The resulting app. is used for the thermometric detn. of the mol. wt. in soln. of several nonvolatile solutes in various solvents. The magnitude of the signal produced by thermistors permits analytical detns. with a precision exceeding 1%.

RADIOCHEMICAL TECHNOLOGY

Decontamination of radioactive surfaces.

Atomic Energy Newsletter, 9, 3, June 30, 1953.

Results of research show that sequestering agents offer the best means for decontaminating radioactive surfaces after an atomic bomb explosion. Sequestrants investigated included ethylenediamine tetraacetic acid, pyrophosphates, tripolyphosphates, as well as citrates. The most economical of all to use for decontaminating purposes was found to be a modified form of Na hexametaphosphate. When used in a soln. consisting of two parts sequestrant, with one part of either soap or synthetic detergent, and applied in a 1% water soln., removal of radioactive contaminants from nearly all surfaces was almost complete. From frosted glass, the sequestrant soln. removed 98.8% of all contamination, against 47% removal by water, and 81% removal by 1% soap soln.

PATENTS

Antioxidant salt and method of preparing the same.

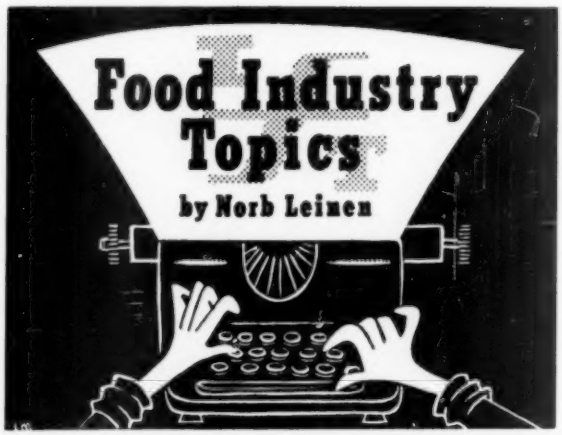
ROMSON, C. S. Assignor to Morton Salt Company. *2,645,581,* July 14, 1953.

A compn. for salting and stabilizing fatty foods against rancidity comprising common salt in crystal form, having substantially all of the surfaces of the salt crystals coated with a thin layer of glyceryl monostearate having dissolved therein an effective amt. of nordihydroguaiaretic acid, and an acid synergist therefor.

Dried milk product for use in coffee or the like and process of producing same.

KEMPF, C. A., AND BLANCHARD, E. L. Assignors to Golden State Company, Ltd. *2,645,579,* July 14, 1953.

In the process of producing a dry milk product which is free from the tendency to feather when introduced into coffee, disodium phosphate is added and the milk is heated to a temp. of from approx. 205° to 320° F. for a period varying from substantially instantaneous heat treatment for the highest temp. to approx. 15 min. for the lowest temp.



. . . in the public interest

Two symposia of national interest were recently held in Chicago under the joint sponsorship of the Committee on Foods of the National Research Council's Advisory Committee on Quartermaster problems and the Quartermaster Food and Container Institute for the Armed Forces.

At the Symposium on Food Acceptance Methodology, October 8 and 9, held at the Palmer House, Chicago, the ideas of scientists working in various phases of this rapidly growing field were interchanged, critiques of the adequacy of various test methods in present use were provided, and a better intercommunication among food acceptance research workers was achieved. Papers and discussion were concerned with methods of predicting consumer response to food and of investigating and controlling food flavors. The plan of the meeting, as organized by Mr. David Peryam and Dr. Francis J. Pilgrim, Quartermaster Institute food acceptance scientists, was to consider methods and approaches now in use in the light of their merits and limitations. The symposium, sixth in a series sponsored by the National Research Council and the Institute, was initiated by Dr. W. G. Parks in coordination with Dr. Donald K. Tressler, scientific director of the Institute, and Dr. Robert G. Tischer, director of the Institute's Food Laboratories. Chairmen who officiated at the two-day conference were Dr. Dean Foster, United States Testing Company, Inc., and Dr. L. L. Thurstone, Psychometric Laboratory, University of North Carolina.

Color as a criterion for measuring the quality of foods was examined by food research workers in a two-day Symposium on Color in Foods, held November 3 and 4, at the Oriental Institute, University of Chicago. The symposium was the occasion for reviewing the status of color investigations and considering the applicability of techniques of measurement to military food supply and storage problems. Section chairmen were Dr. A. N. Prater, Gentry Division, Consolidated Grocers Corp.; Dr. C. R. Fellers, Food Technology Department, University of Massachusetts; Dr. E. M. Mrak, Food Technology Department, University of California (presently in residence in Chicago as consultant to the QM Institute); and Dr. Gordon Mackinney, University of Cali-

fornia biochemist, long active in color investigations relating to food problems. Represented at the symposium in addition to U. S. scientists were specialists from Great Britain and Canada, thus giving an international hue to the color symposium.

The proceedings of both of the above symposia, including the papers in full and the essential discussion, will be published within the next few months.

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N. Y. canners' association and university officials welcome scholarship winners starting food technology course at the Agricultural and Technical Institute of the State University of N. Y. Twenty-eight such scholarships have been given in the past four years by N. Y. State Canners & Freezers Association and individual canning companies. Front row, left to right: Charles J. Zeitvogel, Bergen, N. Y., winner of Haxton Foods, Inc. scholarship; Richard E. Todd, Ogdensburg, Arthur E. Nash Memorial Scholarship (Association award); Dr. Edward S. Hamilton, assistant director of the Institute. Second row: Gary L. Putnam, Brocton, Pfeiffer's Food Products, Inc., scholarship; Association president Walter W. Wilson, Silver Creek Preserving Co.; Vincent J. Della Rocca, Brooklyn, Lyndan Products Division of S. Gumpert Co., Inc.; Walter B. Rohde, Jr., Syracuse, Libby, McNeill & Libby (Hall, N. Y. branch); John F. Reynolds, Lima, Olney & Carpenter, Inc. award. Top row: Robert H. Snow, Dalton, Mass., Comstock Canning Corp. scholarship; Ronald I. Faro, Williamson, Fern Shannon Scholarship (Association award); Professor Royson N. Whipple, Food Technology Division head; Association secretary William H. Sherman.

◆ ◆ ◆

The sea around us is a vast and virtually untapped reservoir of food, and as such should receive far more attention than it is getting from a world with a rapidly growing population, writes Dr. Francis J. Weiss of Washington, D. C., scientific consultant on food and nutrition and an IFT member in a recent issue of the *Journal of Agricultural and Food Chemistry*. Dr. Weiss points out that more than 71 percent of the earth's surface is covered by water, most of it gathered in oceans which are teeming with plants and animal life, but only a small portion of this great potential food harvest is now being reaped. Commenting on the possibilities of producing more food from the sea, Dr. Weiss concludes: "Only by way of nutritional education, by changing ingrained but inadequate food habits, by improving the purchasing power and living standard of backward nations, and by facilitating the free flow of commodities will it be possible to achieve a fuller and economically justifiable utilization of the large food resources of the oceans."

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Last month's column began with an excerpted portion of a letter sent to leaders of the food industry by Agriculture Secretary Benson. The Secretary cited the great accumulation of problems associated with agricultural surpluses and expressed the conviction that only through a greatly expanded research program, fully supported by the industry, could these problems be solved. Quoted below is a portion of the reply from one recipient of the letter—Mr. Victor W. Henningsen, president, Henningsen, Inc., 347 Madison Ave., New York 17, N. Y. Writes Mr. Henningsen:

"Our company has been actively carrying on research on egg products for the past 15 years. I believe we are spend-

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FOOD INDUSTRY TOPICS

ing more money on egg research than any other business concern in the United States today, and we believe it is money well spent.

"I am strongly in favor of increased appropriations for agricultural research. I believe the returns to the American farmer and the over-all American economy will pay off in the long run $1000 for each dollar spent.

"More emphasis should be placed on basic research. This is the fountainhead for all applied research. Scientists working on basic research should not be under pressure. They cannot come up with new discoveries on any time schedule. They need security in their jobs, peace of mind, and if they are well qualified for the work they are undertaking, and are properly directed, good results will be forthcoming."

. . . *things new under the sun*

A new machine, the EXACT-O-FILL, to measure, fill, and seal sausage and other semi-viscous products in synthetic casings, has just been introduced by the Globe Company, 4000 S. Princeton Ave., Chicago, manufacturers of all types of equipment for the meat industry. The semi-automatic machine fills exact weights of product into continuous lengths of casing, seals off each length with an aluminum clip, and cuts the link free—all with only one operator. It measures from six to 20 ounces in one link, saves 20 percent in casing costs, up to 75 percent in labor costs, and improves package appearance and sales appeal, according to the company. Also available as separate units are the EXACT-O-FILLER, which meters exact weights of semi-viscous material, is air operated and is adjustable from six to 20 ounces, and the EXACT-O-CLIPPER, which gathers and seals the casing tight with an aluminum clip and closes both ends of the link.

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A new line of improved BLAK-RAY (blacklight) lamps designed for use in difficult inspection procedures, in flaw detection, control, processing, for invisible marking, coding, and other manufacturing operations, as well as for agricultural product examination and inspection, is announced by Ultra-Violet Products, Inc., South Pasadena, Cal. Because fluorescence due to activation by long wave ultra-violet (commonly called blacklight) is caused by energy of shorter wave lengths than those in the visible spectrum, it requires a much more optically correct source and reflector than is found in conventional fixtures. The fact that over 3000 substances are activated by invisible ultra-violet blacklight so they flow or fluoresce in different shades and colors is the basis for this new, faster method known as "fluorescent inspection." Many materials which are said to be only slightly fluorescent or even non-fluorescent still exhibit marked differences under this irradiation. BLAK-RAY "light" is non-injurious, harmless to eyes or skin, and has no deleterious effects on products. BLAK-RAY lamps burn cool, start and restart with no warm-up or cooling-off period required, and replaceable tubes last 3000-6000 hours. Units range in size from four to 120 watts. For complete information write for Inspection Bulletin.

Relative freedom from odor contamination when repainting interiors of grocery stores and food processing plants is now possible with Du Pont odorless enamels, according to a recent announcement by the company. The firm is reportedly the first national manufacturer to offer odorless paint in gloss and semi-gloss as well as flat.

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The Southern Regional Research Laboratory, USDA Bureau of Agricultural and Industrial Chemistry, 2100 Robert E. Lee Blvd., New Orleans, La., reports the following recent research results: (1) The distribution of phosphorus compounds in cottonseed kernels, basic to the nutritional values of the meals, varies according to variety of cotton and environment during development of oil in the seed. Temperature and rainfall have more effect than variety of cotton. (2) The variety of cotton and the environment influence the iodine value of the extracted oil. Temperatures prevailing during the time the oil is being developed in the seed have particular influence. Oils of high iodine values are used to produce winterized salad oils. (3) A process has been worked out for easily producing hydroxystearic acid from a component of cottonseed oil. This acid has the hydroxyl group at the 10 position on the carbon chain. The hydrogenation process was developed in research conducted to derive hydroxystearic acids from a domestic oil as a possible replacement for hydroxystearic acids now obtained from castor oil and used as an ingredient in specialty greases.

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Commercially pure Titanium, precision-rolled to very close tolerances and to thin gauge and foil, for use in the chemical, food processing, and bottling industries, is now readily available from the Industrial Division, American Silver Co., Inc., 36-07 Prince St., Flushing 54, N. Y. Titanium, an extremely strong, yet lightweight metal, can be compared favorably in strength to many steels, but weighs only 56 per cent as much. It possesses excellent corrosion resistance and the ability to withstand high temperatures. Titanium is rolled by American Silver Company in strip up to 8 inches wide and down to .0005 inches thick, to tolerances as close as .0001 inch. The strip is available in any quantity from one pound to thousands of pounds. Typical uses for Titanium strip in the chemical, food processing, and bottling industries include: instrument parts, condensers, metering equipment, valves, pumps, etc.

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A new, upright, drawer-type freezer for home use incorporating exclusive patented features and designs tested in their commercial installations since 1938 is being introduced by Iceberg Freezer Corp., 203 N. Wabash Ave., Chicago 1, Ill. The upright design of the Iceberg, combined with the drawer features, permits 100 per cent storage efficiency and requires minimum floor space. Drawers allow easy access to stored food without bending, eliminate packages falling out, and only one drawer at a time need be opened, thus avoiding exposure of the entire contents of the freezer to room temperature. The manufacturer points out that the Iceberg is the only home freezer with an automatic defroster and controlled temperatures which prevent ice formation in the cabinet or on the food packages. The construction permits a continuous circulation of cold air throughout each of the three drawers to prevent contamination or mixing of food odors. The new freezer, now in production, is the first and largest of three sizes scheduled for the consumer market. The drawer unit is 70 inches high, 38 inches wide, 28½ inches deep, and has a capacity of 19 cubic feet. The company is now appointing distributors throughout the country in preparation for national distribution.

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From the Southern Regional Research Laboratory of the USDA, New Orleans, La., comes word of a margarine-like product which is spreadable at temperatures well below zero and well above 100° F., and which keeps better than margarine or butter. The new product can be prepared by use of new, modified fats—aceto-oleins—in a formula with highly hydrogenated cottonseed or peanut oil. The Laboratory researchers have developed the new fats through chemical substitution of acetic

acid for part of the fatty acids in oleins, which occur in most vegetable oils. If aceto-oleins pass edibility tests now underway, the wide plastic range of the spread (5° to 120° F., with about 79 per cent modified fat as the liquid phase and about 18 per cent hydrogenated oil as the solid phase) and its good resistance to deterioration (due to a low degree of unsaturation in aceto-oleins) will be of interest for an all-climate spread desired for Army use. A spread of better mouthing quality, but of somewhat narrower plastic range, is obtained with about 66 per cent modified fat and about 30 per cent partly hydrogenated oil.

. . . the literary corner

A new free booklet titled, "How Distilled 'Mono' Creates Eating Quality" has just been produced by Distillation Products Industries, division of the Eastman Kodak Co., Rochester 3, N. Y., to provide data on their Myvatex Food Emulsifier, Type 5-40. The emulsifier—a soft, pure white plastic fat that becomes part of the shortening—is concentrated monoglyceride which is derived entirely from prime steam lard and the highest grade of glycerine. Purified and concentrated by molecular distillation, the product has shown unique effectiveness in baked goods where its uniform behavior and appearance have proved of great value. The booklet provides data on the suggested amount of Myvatex to add to whatever amount of lard is used in the production of white bread, rolls, or buns. Pictures trace the production of bread in a large, modern bakery and show the contribution made by the emulsifier at each stage.

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The *Givaudan Flavorist, No. 2*, 1953, published by Givaudan Flavors Inc. 330 W. 42nd St., New York 36, N. Y., features an absorbing article, "The Art in Imitation Flavors," which delves into the mysteries of the aromatic constituents of strawberry. Of particular interest are the analyses of the various basic component parts of the strawberry flavor, including the "fruity or ester note," "butter note," "sweet note," "balsamic character," "rose-honey characteristics," "straw or hay flavor," and "sour and citrus notes."

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The complete results of an American Management Association survey on present-day marketing research practice among 168 respondent companies have been published by the association as a 64-page book, designated Research Report No. 22 and entitled, "Company Practices in Marketing Research." Copies are available from the American Management Assn., 330 W. 42nd St., New York 36, N. Y., at a price of $1.75 each to A. M. A. members, and of $2.50 each to non-members.

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Fritzsche Brothers, Inc., Port Authority Bldg., 76 Ninth Ave., New York 11, N. Y., announces the publication of its latest Price List on its line of essential oils, aromatic chemicals, and allied products. The Price List is available to those who buy in wholesale quantities.

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Techniflex Corp., Port Jervis, N. Y., report development of a number of relay interlock devices which, when set up in proper sequence, control the most complicated liquid level and/or mixing chores. Using conventional proves and relays, the Techniflex "brainchild" can be varied in sequence to perform hundreds of intricate processing functions automatically. The firm has compiled literature which gives the complete story and is

hu-mec'tant

A substance having affinity for water, with stabilizing action on the water content of an article.

Example: GLYCERINE!

When product moisture content must be kept constant in spite of fluctuations in humidity, leading manufacturers of foods, drugs and cosmetics rely on U.S.P. Glycerine. For many years Glycerine has been the humectant in such famous products as Chase "Pep-R-Mints" and Pine Brothers Cough Drops.

If you're developing a new product that will contain a humectant, be sure to check Glycerine.

'Cereal Bar'

For example, the U. S. Army Quartermaster Corps recently developed a compressed, premixed cereal for ration kits and survival rations. They chose U.S.P. Glycerine as the edible binder because it enhances sweetening, while restraining stickiness, spoilage, and mold growth, and—most important of all—because it is non-toxic.

Balance of Properties

You can see that humectant action is only a small part of the Glycerine story. *Versatile* Glycerine can also serve as—

emollient	**lubricant**
solvent	**demulcent**
plasticizer	**suspending agent**
sweetener	**chemical intermediate**

Booklets on the application of Glycerine in the food, drug and cosmetic, protective coatings, and textile fields are available. For your copy, write Glycerine Producers' Association, 295 Madison Avenue, New York 17, N. Y.

Nothing takes the place of Glycerine

FOOD INDUSTRY TOPICS

complete with schematic drawings. The latter represent the solutions to typical processing problems. The company reports that its engineers have yet to find a unit operation problem which could not be completely solved through use of this new relay interlock system. For this literature, write the Techniflex Corp., at the address given above. For solutions to specific problems, forward a schematic flow sheet together with an outline statement of specific sequence requirements involved in the problem to the company's Instruments Division at the same address.

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The September issue of the *Gentry Serenader*, published by Gentry Division of Consolidated Grocers Corp., Los Angeles, Cal., reports that federally inspected meat packing plants operating under regulations of the Bureau of Animal Industry, Meat Inspection Division, may now delete the word "dehydrated" from labels of meat food products when dehydrated onions or dehydrated garlic are used. However, the Bureau points out that "this conclusion should not be regarded as a precedent for other dehydrated ingredients which may be included in meat or meat food products. Each will be considered on its own merits."

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A little booklet from Mr. Robert K. Phelan, president, Taconic Farms, Inc., Germantown, N. Y., graphically presents that organization's facilities for the breeding of laboratory mice. Mr. Phelan points out that this firm buys no mice, and is currently mass breeding Swiss Mice, Webster strain, in two separate colonies. Because of large production and accurate technical control on all breeding factors, it is possible for Taconic Farms to ship out large numbers of particularly uniform mice year after year. In addition, reserve quantities of animals are maintained to take care of urgent laboratory needs over and above regular orders.

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For salesmen and others attending meetings and conventions, TRIP-CHARGE INC., 5th Ave. at Hamilton, Pittsburgh 6, Pa., offers a free booklet describing possible tax savings. Savings suggested cover expense items of every kind, including gratuities and gifts. TRIP-CHARGE INC. is a national credit card company. Card holders are able to charge travel expenses throughout the country, including restaurants, hotels, florists, car rental, and retail stores.

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The September number of *Fatty Acid News Digest*, published by Fatty Acid Division, Assn. of American Soap & Glycerine Producers, Inc., 295 Madison Ave., New York 17, N. Y., cites the following items of interest culled from the recent technical literature: a new technique for removing very short chain fatty acids from coconut oil; a listing of chemicals and specialty products introduced since September 1952; a new bibliography containing abstracts of all the literature in the distillation field, arranged by subjects; a comprehensive compilation of the patents and processes used in hydrogenation and hydrogenolysis.

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Bulletin! From Minneapolis-Honeywell, that is, describes industrial hair hygrometers and thermometers, recorders, and recording controllers. Ask for Bulletin 6504. Buletin 1541 illustrates and describes a 6½-inch wide Vertical Scale Indicator for the rapid and precise multiple indication of any variable (temperatures, rotational speeds, and all forms of energy) that can be transformed to millivolts. Designed for applications where panel space is at a premium, five of the instruments can be mounted in a panel space needed for two comparable circular scale indicators. Two models are available—one with 12-second, full-scale travel, and the other with 4½-second, full-scale travel. Two data sheets from the same company describe other new equipment. Instrumentation Data Sheet 10.18-4 describes Electronic Scale and Printer manufactured by Gilmore Industries, Cleveland, O., and used in the chemical and other industries for conveyor, platform, hopper, or tank weighing. The sheet also describes Gilmore Electronic Scale for monorail and floor-operated cranes, and Brown servo components utilized in these systems. Instrumentation Data Sheet 10.18-3 describes the Trans Weight Belt-Meter, used in the continuous weighing of a steady flow of loose material on a conveyor belt, the recording of rate of flow, and the totalizing of the accumulated tonnage. For any of this literature write Minneapolis-Honeywell Regulator Co., Industrial Division, Station 64, Wayne & Windrim Aves., Philadelphia 44, Pa.

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The September 15 *Information Bulletin*, published by The Refrigeration Research Foundation, 200 Midlands Bldg., Colorado Springs, Colo., contains this thought-provoking item: "In spite of our wealth of statistics, we must continue to grasp and grope for total significance. The fact that Japan has the largest national fishing fleet (300,000 craft) and that the USA is second with 90,000 fishing craft suggests that much oceanic wealth is unexplored and unexploited. In the USA during the last four years, frozen orange juice concentrate has increased from 200 million to 1,200,000,000 6-ounce cans—clear evidence that the freezing process has taken over a large portion of the orange crop. In the great dairy industry, condensed and evaporated canned products account for only about 5 percent of the total 115 billion pounds of milk produced annually. That statistical fact measures the opportunity for a good freezing process (probably including concentration) for milk (fluid whole and skim). Total world industrial production rose 62 percent—US industrial production 95 percent—in the past 15 years, and that fact suggests that good new industrial processes (including freezing and concentration for foods) are a good way to supplying populations and keeping them out of hunger, trouble and wars. Other studies show that if prices, wages, and the depression-prosperity cycle go in the right direction, we will have a healthy stimulation in consumption of industrially processed goods—soon, we hope. All of this suggests that groping for statistical significance is mentally stimulating. Filling out the statistical dreams with facts, however, will require some mighty powerful doing."

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In the Fall 1953 edition of the *Chemical Digest*, published by Foster D. Snell, Inc., 29 W. 15th St., New

York 11, N. Y., we find the following "Recipe for Profit": (1) develop new products; (2) discover new materials; (3) improve existing products; (4) adapt products for new markets; (5) simplify manufacturing processes; (6) develop labor-saving machinery; (7) simplify quality control; (8) find substitutes for expensive or critical materials; (9) create values from wastes; and (10) evaluate diversification or expansion plans. There you have it. Now DO it!

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A new 20-page, two-color catalog, now being circulated by Union Iron Works, Erie, Pa., covers the diversified line of Union steam generators and allied equipment. Described are eight basic arrangements of two, three, and four drum steam generators furnished to meet a wide range of loads, pressures, and temperatures for power, process, and space heating; heat recovery units, including fire tube and water tube boilers, plain tube and cast iron extended surface economizers; Union process equipment including Dowtherm vaporizers, reaction kettles, autoclaves, heat exchangers, and liquid heaters. Design drawings and photos are accompanied by brief summaries of salient features for quick reader analysis. Copies of *Bulletin G. B.-153* are available without charge.

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A new 16-page bulletin, describing dial thermometers for long distance measurement, has been issued by The Foxboro Company of Foxboro, Mass., manufacturer of industrial instruments for the measurement and control of process variables. Emphasizing the variety of ranges, and the bulbs, tubing, and accessories available, the bulletin provides complete data on temperature indicators of the vapor pressure and gas pressure types. A separate section gives details of construction, helpful in understanding the precision performance of the instrument. Discussed in detail is the exclusive ball and trough movement which, by eliminating all connecting links, avoids loss of motion either up or down the Fahrenheit scale. Copies of the new bulletin, 467, will be sent on request.

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A beautifully done 56-page booklet, profusely illustrated and containing numerous charts and maps has been received from British Information Services, 30 Rockefeller Plaza, New York 20, N. Y. Entitled, "Golden Harvest," it relates the story of the Gold Coast Cocoa Industry.

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The September copy of the *Industrial Bulletin* of Arthur D. Little, Inc., consulting chemists and engineers of Cambridge, Mass., contains a thought-provoking article entitled, "Algae versus Malthus," tracing the work of the Carnegie Institution of Washington in establishing the feasibility of large-scale culture of algae, the lowest form of plant life, as a source of food for humans and animals and of organic matter for industrial uses. After World War II, the Carnegie organization retained Arthur D. Little, Inc., to build and operate a pilot plant on a much larger scale than had previously been possible. The product of the pilot plant was used for chemical and nutritional studies. These established that materials such as vegetable oils, sterols, and chlorophyll can be recovered, but it is the nutritional value of *Chlorella pyrenoidosa* which seems to offer the greatest promise. The dry *Chlorella*, containing about 50 per cent protein and up to 20 per cent fats, along with most of the natural vitamins, is the nutritional equivalent of yeast. Thus, as the article states, "once more technology challenges the Malthusian doctrine."

. . . *meeting hall and conference room*

At the recent 124th National Meeting of the American Chemical Society, held in Chicago, a number of ideas of above-average interest were presented to the membership. Mr. D. C. Spence of the Smith-Douglass Co., Inc., Norfolk, Va., stated that a supposedly undesirable by-product of the fertilizer industry—often

IS YOUR FOOD PRODUCT LISTED HERE?

	Dehydrated Soups	Ice Cream Stabilizers
	Dessert Mixes	Marshmallow Toppings
	Flavoring Emulsions	Meringues
Aspics	French Dressing	Milk Puddings
Beer	Frozen Fish	Pie Fillings (Dry)
Beverages	Frozen Fresh Fruit	Pumpkin Pie Filling
Cake Icings	Frozen Fruit Juices	Ripple Ice Cream Syrup
Canned Fruit	Fruit Fillings (Pie)	Sauces (Prepared)
Cheese Spreads	Fruit Juices	Sherbet Stabilizers
Chocolate Milk	Fruit Pie Fillings	Soups
Chocolate Syrups	(canned, ready-to-serve)	Syrups
Confectionery	Gas Whipped Cream	Water Gel Desserts

. . AND YOUR IMPROVEMENT PROBLEM HERE?

- ☐ Binding
- ☐ Bodying
- ☐ Emulsifying
- ☐ Gelling
- ☐ Modifying
- ☐ Stabilizing
- ☐ Suspending
- ☐ Thickening
- ☐ Custardizing milk & products containing milk solids
- ☐ Improving mouth-feel and flavor
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discarded as a hazardous, irritating waste—is a vast potential source of valuable chemicals called silicofluorides for use in laundering agents and in the manufacture of gasoline, metals, and foam-rubber. A few relatively simple chemical steps, he explained, can convert the fluoride-containing gases given off in the superphosphate production process into sodium or potassium silicofluorides—valuable chemicals which have wide industrial application today. Messrs. J. M. Stinson and C. E. Mumma of the Tennessee Valley Authority's Division of Chemical Development at Wilson Dam, Ala., outlined two promising methods for recovering sulfuric acid from phosphogypsum, a waste byproduct of phosphoric acid production. When phosphoric acid is made by the wet-process method, the phosphate rock is treated with sulfuric acid. The sulfur from the sulfuric acid ends up as phosphogypsum. The TVA studies indicate that the sulfur in this phosphogypsum may be recovered economically as sulfuric acid, which may be reused in the phosphoric acid production process. Utilization of this waste material, the TVA men pointed out, would reduce the requirement for sulfuric acid and would aid in the conservation of the country's sulfur reserves. Dr. Daniel Swern, chemist in the Eastern Regional Research Laboratory, USDA, Philadelphia, Pa., predicted that fats will take their place beside coal and petroleum in the near future as a major source of chemicals to help supply fuels, dyes, paints, drugs, plastics, insecticides, and hundreds of other products vital to the Nation's welfare. He mentioned that we are already entering a period in which fats, derived from animal and vegetable sources, will become the raw materials for large quantities of "oleochemicals," comparable with the coal tar chemicals and the "petrochemicals" from petroleum.

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Bottlers brushed up on their technical know-how at the three special afternoon meetings of the 35th Annual Convention of the American Bottlers of Carbonated Beverages, held in Chicago on November 10, 11, and 12. Authorities from across the nation presented the latest information of use of insecticides in bottling plants, profit planning, production pitfalls, bottler's sugar, and new developments in bottle brushes and rinse spindles. Answers to many problems were revealed at three panel sessions which covered production, sales, and general policy. Leaders in these fields participated in the discussions and brought the latest ideas and methods to the attention of those present.

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More than 5,000 models and component parts of refrigeration and air conditioning equipment will be on display at the Refrigeration and Air Conditioning Exposition in Cleveland, Nov. 9-12, it was revealed in a survey conducted by the Refrigeration Equipment Manufacturers Assn., sponsors of the show. Total value of the exhibits will be in excess of $2,000,000. The show, greatest the industry has had, has been completely sold out. A total of 225 companies will participate. It will cover an area of more than 63,000 square feet of net exhibit space. About 15,000 executives from every branch of industry are expected to attend, with 2,500 experts on hand to answer visitors' questions. Reflecting the widespread interest in new techniques of refrigeration and air conditioning for both industrial and residential uses, as well as for new merchandising techniques, the exhibiting companies will show a wide variety of machines never before seen at previous shows. In the refrigeration field, interest will be concentrated on many new industrial processes which use low temperatures in manufacturing. Another major attraction will be the many new cabinets used for retail sale of products which require refrigeration. Household and institutional mechanical refrigeration units will occupy another large segment of the show. Almost all companies which manufacture equipment for this latter type of user will show new models for 1954. Although a good deal of interest will center on complete working units, many exhibitors will show component parts. Because of new industrial uses in factories, the display of these component parts is expected to have special significance for industrial engineers.

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When the newspaper food editors held their conference recently in Chicago, they were entertained by Nebraska Consolidated Mills, Omaha, licensed manufacturers and distributors of Duncan Hines Mixes. Gathered here discussing the latest product, Duncan Hines Spice Cake Mix are (from l. to r.): Evan Reicheldorfer, director of quality control, Hines-Park Foods, Ithaca, N. Y., licensing organization; Duncan Hines; Helen Rotte, Nebraska's new home economist, formerly with the Wheat Institute; and Arlee Andre, Nebraska vice-president and director of research.

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Armour Research Foundation of Illinois Institute of Technology and the Trade Association Executives Forum of Chicago will co-sponsor a conference on trade association technical problems at the Technology Center, Tuesday, November 17. Members of the American Trade Association Executives and other association executives are being invited to attend the one-day affair, called the Trade Association Technical Conference. The symposium is designed to show how any association, including limited budget groups, can play a vital technical role for its members in research, gathering and utilizing information, industry-wide testing and standardization, technical and economic predictions through research, and training for industry production men. The morning session will be devoted to speakers from trade associations which have active technical programs benefiting their industries. The afternoon session will consist of a round table discussion.

. . . building up and branching out

A new pilot plant center of the Plastics Division of Celanese Corporation of America is nearing completion as an addition to the present facilities of the company's Summit, N. J., Research Laboratories. Reflecting the firm's emphasis on expansion in the synthetic resin and polymer field, the new plant will provide equipment for the program of the Process Engineering Section. Plans are underway to build experimental units for process and production research involving current Celanese plastics, such as polyesters, and new polymers.

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In a move to enlarge its Metal Division operations in the Florida citrus area, Continental Can Company has

begun construction of a new building in Winter Haven, to house its present Tampa district sales office. The building is a modern, one-story structure covering 3300 sq. ft. of floor space. In addition to the sales office, it will also be headquarters for the company's credit and research departments and the closing machine supervisor's office. There will be direct teletype service between the new Continental office and the firm's Tampa, Auburndale, and Winter Garden plants. The central location was selected to make possible faster and more efficient service to the surrounding citrus and food industries.

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A vacuum furnace for annealing tubing of the two "new" metals, titanium and zirconium, is being installed at Norristown, Pa., plant of Superior Tube Co. The new furnace is the batch type, can handle tubing in lengths up to 24 feet. The company is installing the furnace to help meet demand for its recently announced line of small titanium tubing. After six years of metallurgical development, Superior has achieved mass production of titanium tubing in OD sizes from .125 inch to 1.5 inch, and in wall thicknesses from .004 inch to .187 inch. This new titanium tubing is particularly in demand for applications where resistance to high temperatures and corrosion are important.

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Allied Chemical & Dye Corporation announces it plans construction of facilities for production of adipic acid, a material which in addition to being one of the intermediates required for manufacture of 6-6 type nylon, is finding expanding outlet in production of adipic esters for use as low temperature plasticizers for polyvinyl chloride and in synthetic lubricants capable of functioning over extreme temperature ranges. Also, adipic acid is one of the components required for a new polyester type of synthetic rubber, known as "Vulcollan," which the rubber companies have reported as being actively under development because of its marked superiority in wear resistance over the conventional types of synthetic rubber. Adipic acid will be manufactured and marketed by Allied Chemical's National Aniline Division. Allied Chemical research has developed an improved process which is particularly adapted for operation in conjunction with its large caprolactam plant now under construction by National Aniline Division at Hopewell, Va. Caprolactam is an intermediate required in production of its new form of synthetic fiber (nylon-6 type) for which a plant is also under construction near Hopewell, Va. These facilities for caprolactam and adipic acid will strengthen the position of the USA on these important materials.

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Arthur D. Little, Inc., industrial research and engineering firm of Cambridge, Mass., will open a new midwest liaison office in Chicago, it was announced by Mr. Earl P. Stevenson, president. The company is expanding its activities in the midwest area, and is establishing the office in Chicago because of the central location to midwest clients. The new office will maintain a staff to carry out technical-economic, technical-audit, and market-research surveys in that area. Mr. John R. Kirkpatrick, a native midwesterner, will be manager of the office, located in the Board of Trade Bldg., Rm. 3832, Chicago 4. He comes to Chicago with broad experience in the economic and research fields, having participated in the industrial development activities of Arthur D. Little, Inc., on behalf of the Puerto Rican Government.

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The American Bakeries Co., bakers of Merita Bread and Cake, have begun erection of an entirely new bakery in Anderson, S. C., for the baking of bread, cakes, and such specialties as fruit cake. The structure is unique in that it provides straight line production with materials coming in one end of the plant and finished bread and cakes going out the other to their wholesale bread distribution vans. Slicers and wrappers are provided between the bread cooler and the distribution platforms. Equipment consists of one 40-foot tunnel type bread oven and bread cooling equipment, full bread make-up department and fermen-

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lation room, plus a cake shop, set up for maximum versatility in the preparation of a wide variety of specialized cakes.

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Thomas D. Shadduck X-ray Company, 138 Front St., Binghampton, N. Y., has been appointed dealer for Broome, Chenango, Cortland, Delaware, Otsego, and Tioga counties by North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y. Shadduck will sell and service Philips medical and industrial X-ray diagnostic and therapy equipment. In addition, it will sell and service the company's constant-potential industrial MG 150/300 X-ray units and the self-contained lightweight portable MG 160 units which are designed to fit the trunk of an automobile.

. . . *the human element*

Dr. John P. Nielsen, formerly with Libby, McNeill & Libby, has joined the staff of the Stanford Research Institute as a physical chemist in the Air Research Laboratory. He will aid the laboratory's studies of the effects of air pollution upon plant life. Dr. Nielsen worked five years in the food concern's San Francisco office managing the western frozen food division. Previously he had been chief chemist with California Frozen Foods, associate chemist and acting section chief with the Western Regional Research Laboratory of the USDA, and research chemist with the National Canners Assn. Dr. Nielsen, an IFT member, received his B.S. degree in chemistry from Utah State Agricultural College and his Ph.D. in physical chemistry from Stanford. His graduate work was largely in the field of air pollution.

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GALLAGHER

BAUER

Two additions to D&O's staff—Jules Bauer (p. 56) and John W. Gallagher who will join the sales staff of the Chicago branch office following a period in New York. Mr. Gallagher has an extensive background in chemical research and sales. Following his graduation from Notre Dame with a degree in chemical engineering, he worked for Sinclair Refining Corp. in the company's Research and Development Laboratories, and was later

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assigned to Sinclair Chemicals, Inc., where he was engaged in market research, product development, and sales. He is currently working toward an M.S. in business administration at Rutgers.

◆ ◆ ◆

Mr. Earl C. Jertson, president of the Seaplant Chemical Corp., New Bedford, Mass., has announced the election of Mr. M. R. Odermatt to the office of treasurer. Mr. Odermatt has been controller and will continue to hold that office in the firm which manufactures SeaKem Colloid Agents derived from Irish Moss and other seaplants. Mr. Odermatt is active with the Controller Institute of America and the National Assn. of Accountants, having served the latter organization as president of the New York Chapter in 1950-51.

◆ ◆ ◆

Mr. T. E. Alwyn, American Can Company vice president, formerly in charge of sales, has been elevated to the firm's executive department where he will work directly with the other principal executive officers in the over-all administration of the company, Mr. Wm. C. Stolk, president, has announced. At the same time, Mr. Stolk announced that Mr. D. B. Craver, general manager of sales, has been elected vice president in charge of sales. In their new duties, both executives will continue to make their headquarters in New York. Mr. Alwyn has been associated with the company for 30 years and Mr. Craver for 25 years.

Canco also announces these other advancements: Mr. J. W. Wardell, formerly commodity manager of the company's Central Division sales department in Chicago, has been appointed sales manager of the firm's Metropolitan New York district; Mr. T. K. Webster, formerly sales manager of the Chicago district, succeeds Mr. Wardell; Mr. J. S. Austin, assistant manager of the Chicago district sales office since early 1952, succeeds Mr. Webster. Excelsior!

◆ ◆ ◆

Mr. A. Barde Rogers has been named head of the Dairy and Poultry Section of the Research Division of Armour and Company by Mr. C. K. Wiesman, manager of the Development Department. Mr. Rogers was graduated from Iowa State College, Ames, and has been with Armour twelve years. His experience has been varied, including work on egg solids, dairy products, fatty acid derivatives, and market development of new compounds. He succeeds Mr. R. H. Forsythe.

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In a crowded itinerary which covered 19 cities in many countries, Mr. Wm. Lakritz, president, and Mr. Jos. H. Fein, treasurer, Florasynth Laboratories, Inc., visited many business houses and discussed trade operations on various levels. According to IFT member Fein, the concentrated program was akin to a hedge-hopping experience, since practically all the travelling was done by air, with frequent stops. Their visit was devoted to making contacts and working out plans for materials on both the import and export levels. Among the nations visited were France, Switzerland, Holland, Belgium, Italy, and Israel. At Grasse, France, Messrs. Lakritz and Fein were guests of Schmoller and Bompard, S. A., distillers since 1880 of famed natural

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FOOD INDUSTRY TOPICS

essences, exclusively imported by Florasynth for distribution in the U.S. and Canada. Both men brought back encouraging reports on the business outlook. From the viewpoint of markets, the nations visited are still very dependent on our country for their dollar sales of such materials as are produced or for financing of their industries, although there is evidence of rebuilding from the chaotic state, the travelers reported.

• • •

Appointment of Dr. C. L. Wrenshall as associate director of the Technical Service Department of Chas. Pfizer & Co., Inc., has been announced by Mr. E. J. Goett, director of sales development for the Brooklyn firm. Mr. George F. Sharrard has been named to fill Dr. Wrenshall's former position as administrative assistant to Mr. Goett. Dr. Wrenshall, a graduate of the University of Saskatchewan and McGill University, Canada, had, prior to joining Pfizer in 1952, served as assistant technical superintendent of Du Pont's Chickasaw Ordnance Works, as head of the Division of Organic and Agricultural Chemistry at Southern Research Institute, and as technical director for Foremost Dairies, Inc. Mr. Sharrard, a University of Michigan graduate, comes to Pfizer from the Westvaco Chemical Division of Food Machinery and Chemical Corp., where he was manager of the Technical Service Division. Previously he had been affiliated with Eastman Kodak.

Mr. Grover C. Long, former sales manager of Koinegay Motors, Durham, N. C., has been appointed to the sales department of Huron Milling Company, 9 Park Place, New York City. With headquarters in Birmingham, Ala., Mr. Long will cover one of Huron's newly designated sales territories in the South under supervision of Mr. W. R. Munro, division manager in Cincinnati, O. Mr. Long's appointment is another development in Huron's current expansion program aimed at providing better customer service.

• • •

Mr. Eben T. Takamine, 63, president of Takamine Laboratory, Inc., Clifton, N. J., since 1930, died recently. Mr. Takamine, born in Tokyo, Japan, of American and Japanese parentage and brought to the United States when he was one year old, was the first Japanese to be naturalized in New Jersey under the McCarran Act. He was graduated from Yale University, School of Science, in 1913. Like his father, Dr. Jokichi Takamine, who was the first man to isolate Adrenalin and whose work in enzymes paved the way for the techniques and methods now used in most fermentation procedures currently used for producing enzymes and antibiotics, Mr. Takamine has contributed greatly to the growth of the enzyme industry. The company, one of the oldest and largest producers of enzymes in the world, will continue to observe the same high standards of quality and service as heretofore.

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Effective August 13, the government order setting new standards for leading varieties of bread and rolls, permits the use of Brewers' Dried Yeast in quantity of 2 parts for each 100 parts of flour without being declared on the label. Now all five classifications of bread may be improved by the valuable addition of Brewer's Dried Yeast.*

*The inactive dried yeast improves flavor and keeping qualities, supplements wheat protein with important amino acids, and adds substantial amounts of natural Vitamin B Complex.

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* INCREASES PRODUCTION TIME by aiding in clean-up so that the entire job is done faster and "on-the-line" time is increased for production.

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I-35

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Dr. Roy E. Morse has been appointed director of research for the William J. Stange Co., Chicago, manufacturers of seasonings, food colors, and anti-oxidants, the board of directors announced recently. Dr. Morse received his Ph.D. in food technology from the University of Massachusetts and Oregon State College. Prior to accepting his present position, he was director of research for Kingan & Co., Indianapolis meat packers. He also held positions with Monsanto Chemical Company and the Dromedary Division of Hills Brothers. In addition to being active in the IFT, Dr. Morse is a member of the American Chemical Society, Society of American Bacteriologists, Society for the Advancement of Science, and the American Institute of Management. He is the author of many outstanding reports in the fields of food chemistry, engineering, and bacteriology, and is food technology editor of *Biological Abstracts*.

MORSE

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Dr. L. V. Burton, executive director of the Packaging Institute, announced the election of Mr. R. J. Dahl, E. R. Squibb & Sons, Division of Mathieson Chemical Co., and of Mr. A. Douglas Murphy, Esso Standard Oil Co., as new directors of the Institute. Members reelected for a second term as directors were Messers: E. H. Balkema, Colgate-Palmolive-Peet Co.; Walter F. Daley, New Haven Pulp & Board Co.; Roger V. Wilson, Continental Can Company; Horace C. Baker, Hudson-Sharp Machine Co.; Herbert T. Holbrook, Standard Packaging Corp.; and T. A. Torrance, Aluminum Company of America. The Board of Directors made these appointments: president—Mr. F. S. Leinbach, Riegel Paper Corp.; vice presidents—Messers. R. Chester Reed, The Texas Company, and Herbert T. Holbrook, Standard Packaging Corp. Dr. L. V. Vurton was re-appointed executive director.

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FOOD INDUSTRY TOPICS

Dodge & Olcott, Inc., New York City, announce the appointment of Mr. Jules Bauer to the newly established post of coordinator of sales. A graduate of Grinnell College, Iowa, where he majored in business administration, Mr. Bauer comes to D&O with an extensive background in administrative and sales activities at General Electric Corp. and Prentice-Hall. With the latter firm, he served as assistant vice president and executive director of college sales. In his new association, Mr. Bauer will work closely with D&O vice president C. O. Homan, and sales manager Paul Sperry at the company's home offices.

♥ ♥ ♥

White Stokes Co., Inc., Chicago, manufacturers of ingredients for the confectionery, bakery, and fountain trade, have named Mr. C. T. Rabenau chief chemist in charge of new product development and quality control. Mr. Rabenau, formerly vice president and chief chemist of Huter Quest Co., Louisville, Ky., is known for the development of "Old Forester Jell," a whiskey jelly, as well as a complete line of "Chiffon Cake Flavors."

♥ ♥ ♥

Mr. Fred W. Hatch, manager of the Julius Hyman & Company Division of Shell Chemical Corp., New York City, distributors of agricultural chemicals, has announced two high-level changes in his sales staff. Mr. Lawrence F. Stayner, formerly sales manager of the division, has been made assistant to the manager and in that position will work directly with Mr. Hatch on general division problems. Mr. James J. Lawler will become sales manager after a brief special assignment in Shell Chemical's New York headquarters. The Hyman Division headquarters are in Denver, Colo.

♥ ♥ ♥

Finally, in closing, just one thought—even if no one did send in a box of cheeses or a basket of fruit—Merry Christmas anyway . . . and a Happy New Year.

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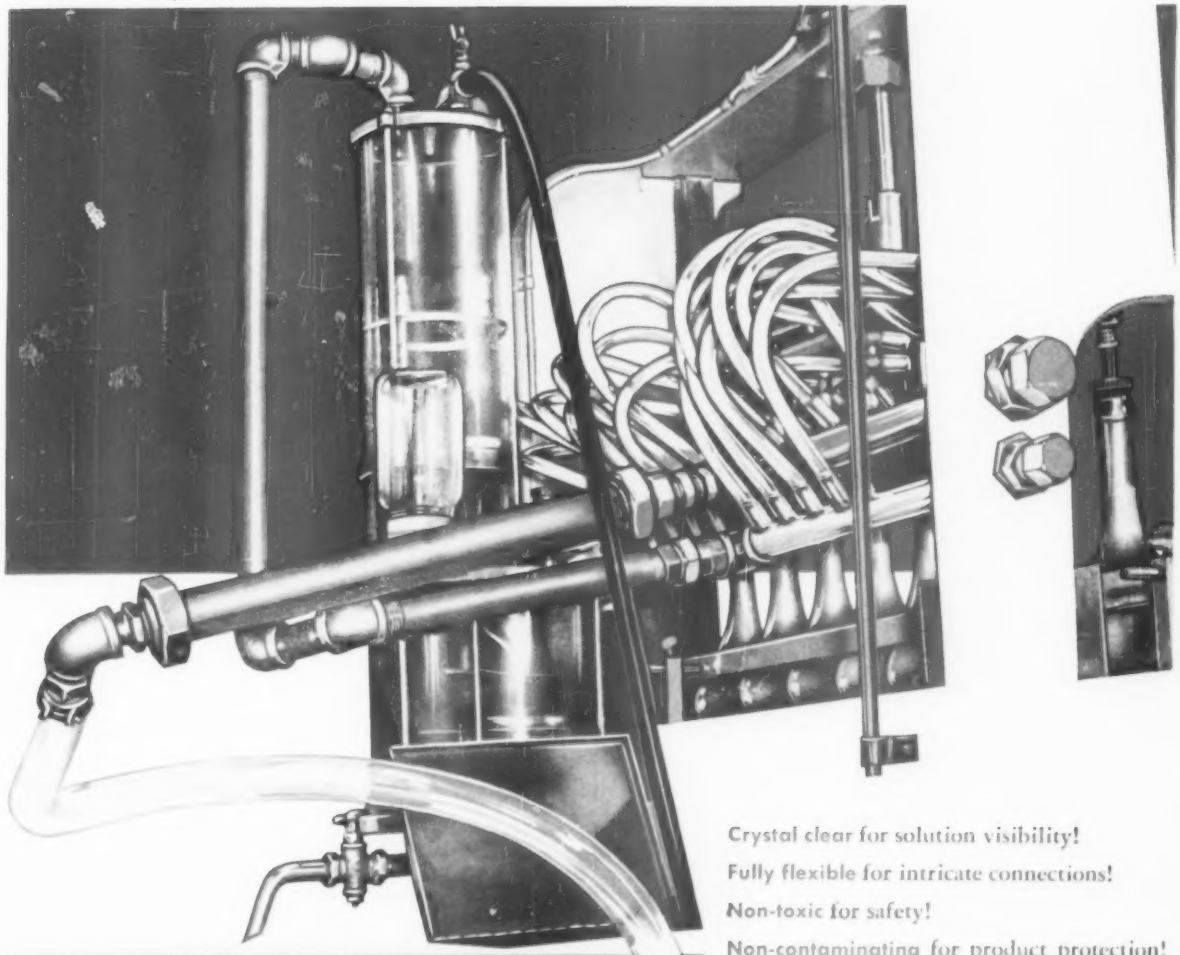

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